

AN
OUTLINE
OF THE
MINERALOGY
OF THE
SHETLAND ISLANDS,
AND OF THE
ISLAND OF ARRAN.

ILLUSTRATED WITH COPPER-PLATES.

WITH AN
APPENDIX;

CONTAINING OBSERVATIONS ON

PEAT, KELP, AND COAL.

BY ROBERT JAMESON,
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EDINBURGH; AND OF THE LINNÆAN SOCIETY, LONDON.

Observationes veras, quam ingeniosissimas fictiones sequi præstat; Naturæ mysteria potius indagare quam divinare.

BERGM. DE FORM. CRYSTALLOR.

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1798.

J. Banks

TO

THE REV. DR. WALKER,

PROFESSOR OF NATURAL HISTORY

IN THE UNIVERSITY OF EDINBURGH,

Ec. Ec. Ec.

THE FOLLOWING WORK IS INSCRIBED,



THE GREAT RESPECT,

AND SINCERE AFFECTION,

OF HIS HUMBLE SERVANT,

THE AUTHOR.

ADVERTISEMENT.

THE AUTHOR regrets extremely, that he is necessitated to leave to others, the care of superintending the press, during the printing of this work. He is sensible that errors may occur, which might have been prevented, had he been himself on the spot; but he hopes the indulgence of the public will excuse any little inaccuracy; and he indulges this hope, with the more confidence, when he considers that the investigations he is now to be employed in, are of an important and interesting nature, the Mineral History of part of the Hebrides being his principal object.

ERRATA.

In the Introduction p. v. l. 15. for *suprepositions*, read *superpositions*.

- PAGE 19. last word of the note, *for Emery, read Imrie*.
 20. last line, *for electrial, read electrical*.
 21. after the analysis, *add, Water and loss 4, 9*.
 32. line last but two, *read pieces*.
 33. at the end, of the third line, *add of*.
 38. in the title, put a comma after Fetlar.
 39. line last but one, *for Lamillar, read Lamellar*.
 42. line 6th, *for losses, read loses*.
 48. line 14th, *for lies, read lie*.
 52. line 1st, *for south, read north*.
 64. line 5th, *for south, read north*.
 68. line 2d, *for Keid-verre, read Keid-vore*.
 99. line 15th, *for Keid-voe, read Keid-vore*.
 123. line 24th, *for Glen-Irsa, read Glen-Ersay*.
 125. line 8th, *for Drumoodon, read Drumodoon*.
 144. line 6th, *for Lampadux, read Lampadius*.
 194. line 3d, after Arran *insert 3½ lb. and*
 line 8th, after Leith Shores *insert 3 lb.*

INTRODUCTION.

MINERALOGY has engaged the attention of mankind, more or less, for a long series of ages ; but, like most other sciences, has risen to importance within a few years only. To the labours of the great Werner, we are indebted for the most accurate discrimination of the species of fossils by their external characters ; these conjoined with the admirable analysis of Klaproth have enabled us to distinguish fossils with certainty, and understand the descriptions of authors, which could not be done from the vague and contradictory characters of Linnæus, and the other Swedish mineralogists. The want of a true systematic arrangement is still to be regretted ; for although mineralogists, from the days of Theophrastus to the present time, have been engaged in this attempt, their success has been but limited. In Botany and Zoology, regular methods have been proposed and followed : in
mineralogy.

mineralogy, however, the greater number of writers, excepting Linnæus and Dr Walker, have discarded the idea of a strict Natural History arrangement, from its supposed insufficiency. This opinion, there can be no question, is extremely false and injudicious; for it will be found upon a strict examination, that fossils are very susceptible of arrangement into Class, Order, Genus and Species thus giving a fixity and regularity to our information of which we can have little idea from many of the methods that have been proposed. It need not be concealed, that in several instances, by joining the external and chemical characters, we will find all our attempts at a satisfactory arrangement in vain: this is not, however, an objection more applicable to the Natural History than to any of the other methods; for all artificial systems are, in some degree, liable to error. What I here principally allude to, is an observation made by an intelligent observer and excellent mineralogist, Charles Hatchet, Esq. F. R. S. who very ingenuously remarks, that many fossils, whose constituent parts are the same, and in a similar proportion, have very different external characters, so that they have been placed in different divisions of the system. To show that this observation is not fanciful, he has numerous interesting series of fossils in his cabinet illustrating the fact, and has collected the analysis from different authors, who could not be influenced by such an opinion.

Not.

Notwithstanding this want of accurate and judicious arrangement, mineralogy has been cultivated in some countries with the greatest ardour and enthusiasm: but it is to the Germans we owe almost the whole of what is known, not only with regard to Mineralogy, but Geology, and that most important concern, the working and œconomy of mines. In Germany, many governments have long since established schools and boards of mines, and the decided pre-eminence which mining holds in all matters connected with mineralogy, &c. is the best proof of the utility of such institutions. This science is now beginning to extend its influence: all nations are following the great example of the Germans: even Portugal, in general little attentive to matters of this kind, has lately sent several intelligent men to collect the information of mining countries. England, yielding to none in the other arts and sciences, is far behind in this respect: it is to be hoped, however, that the ardour for useful information, which has always characterised that country, will soon extend its influence to the cultivation of one of the most interesting and useful of the sciences. Ireland, through the labours of its brightest ornament, Mr Kirwan, and some other distinguished patriots, is now enriched with a collection, which will not fail to diffuse a taste for such kind of investigations, and will certainly prove of much consequence to a country whose mineral history, we may safely say, is utterly unknown. Scot-
land

land, although rich in mines, and presenting a great number of promising mineral appearances, is but little known. The method of working is, in many places, ill understood, and the ignorance of the generality of mine-masters shows the necessity of mineralogical schools.

The utility of such institutions cannot be doubted : a regular and systematic course of any art or science is always to be desired : it is from such institutions that accurate and judicious observers issue, although not there that the most important improvements may be made. Mens minds, when once stored with the well authenticated information of an able teacher, are more ready in any case to apply their knowledge with judgment, and show their superiority over the rude observer, who may want or despise such opportunities. In the art of mining, how many instances have we of useless expence, and ruin entailed upon foolish projectors, from a want of proper information ? It is upon such occasions that the disappointed schemer feels his inferiority, and regrets his loss.

The outline which I now lay before the public may be thought tedious : it is true I have not followed the usual plan of a *medley*, having adhered entirely to mineralogical observation, without deviating, in any instance, to general subjects, which only distract our attention, and please the fancy, without any real advantage. What
I here

INTRODUCTION.

I here aim at is to be a faithful narrator of the appearances which nature presented to my view. This may appear to some an easy business : to me it has peculiar difficulties. The observance of nature in a cabinet, and among the mountains of a wild country, are very different employments : in this last, not only the multiplicity of the appearances, the wonderful and tremendous scenery, but the frequent occurrence of storms, and the obscurity which nature, by these means, throws over the most interesting productions, make us liable to error, notwithstanding our greatest care and attention. To conclude, when it is considered that, in such situations, we are often obliged to examine, not only the different mineral substances, but also their numerous gradations, the position of strata with their various turnings and superpositions, I hope these sheets will not be viewed with the eye of severe criticism, but with that indulgence which one naturally claims, whose chief appeal to an impartial public is this, that these are the notes of one young in a science, in which the most experienced of its votaries are often embarrassed.

CON.

I have aimed at it to be a faithful picture of the appearance
which nature presented to my view. There may appear to
some an early departure; to me it has peculiar difficulties.

1. The Committee on the Status of Women in the United States, which was organized in 1947, has been very active in its efforts to improve the status of women in the United States.

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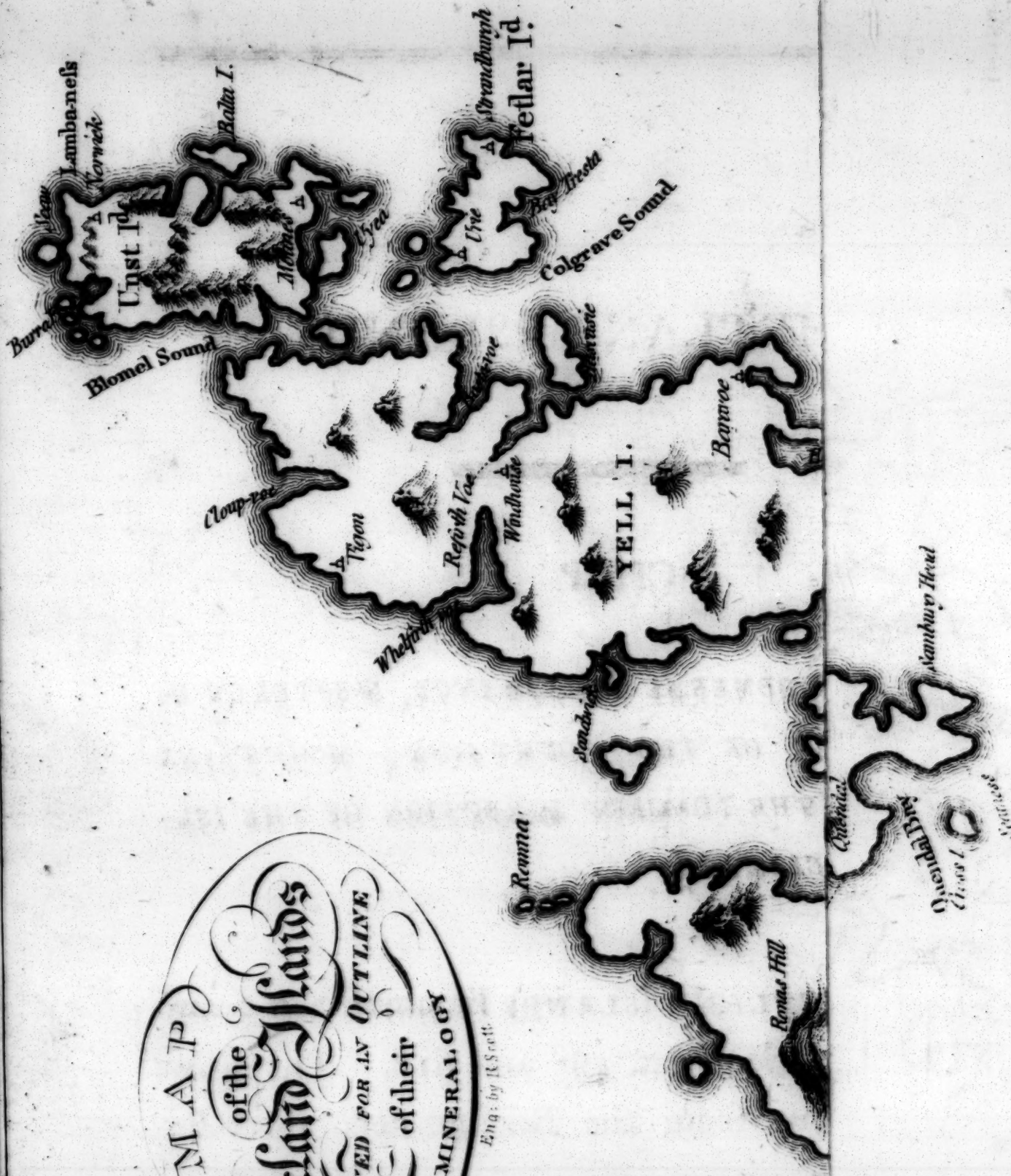
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MAP
of the
Shetland Islands
ENGRAVED FOR AN OUTLINE
of their
MINERALOGY

Eng: by R. Scott



SHETLAND ISLANDS.

CHAP. I.

SITUATION, GENERAL APPEARANCE, WESTERLY ELEVATION OF THE MOUNTAINS; MOUNTAINS RUN IN THE LONGEST DIRECTION OF THE ISLANDS; CLIMATE.

THE SHETLAND ISLANDS lie north east from Orkney, between lat. 59° and 61° . The nearest are distant from the Buchan-nefs, forty-six leagues; sixteen or eighteen leagues north from the island of Sanda, one of the Orkney islands; six or seven leagues north east from the Fair
A island;

This is a detailed black and white engraving of a map of the Shetland Islands. In the top left corner, there is an oval title box containing the text "MAP of the Shetland Islands ENGRAVED FOR AN OUTLINE of their MINERALOGY Engd by R.Scott". The map itself depicts the main islands of Shetland, including Unst, Yell, Papa, and Lewis, along with many smaller islands and skerries. Numerous geographical features are labeled, such as "Romas Hill", "Mickle Roe", "Sandness", "Lerwick", and "Dunrobin". A scale bar is located at the bottom right, showing distances from 0 to 15 miles. A dashed line points from the bottom left towards the island of Foula, with the text "Bearing to the Island of Foula". The map is oriented with North at the top.

island; fifty-eight leagues east from the Faroe islands, and nearly the same distance north-west from the Lewis.

These islands are very numerous, but few of them of any considerable magnitude; thirty-three are said to be inhabited, of which the largest is the Mainland.

On viewing these islands in general, a wonderful scene of rugged, bleak, and barren rocks presents itself to our view. No tree or shrub is to be seen to relieve the eye in wandering over these dreary scenes. Sometimes, however, a few scanty portions of cultivated ground, catch the eye of the traveller, exciting emotions of pleasure, and forming a striking contrast to the barren heath-covered mountains which skirt them. The western part presents many scenes, as wild and sterile as can well be conceived; grey rocks, rising from the midst of marshes or pools, and shores bounded by awful sea-beat precipices, do not fail to raise in the mind ideas of desolation and danger.

The coasts are in general rugged and precipitous, presenting in many places, scenes truly grand and magnificent; vast rocks of various heights, dreadfully rugged and broken, opposing their rude fronts to all the fury of a tempestuous ocean; which in some places has formed great detached pillars, in others has excavated grand natural arches and caverns, that mock all human magnificence, and strike the beholder with that awe and wonder, which must affect every one on viewing these amazing wrecks of nature.

The east side of the Mainland, as is also the case in the other larger islands, is comparatively low, but on the west is remarkably lofty, rugged, and broken, and many of the mountains are sensibly more steep on the west, than on the east side. This geological fact, was first remarked by Dr Walker, Professor of Natural History, in the University of Edinburgh. It first occurred to him in the hills in the vicinity of Edinburgh; but he also found it to hold true in the Lomons, and in all the other hills in the Highlands, of Scotland. We also know that the west coasts

of Scotland and England, have a gradual slope towards the east, and the course of all the great rivers, as the Spey, Tay, Tyne, Trent, and Thames, is from west to east. Upon examining other countries the same phenomenon presents itself. Thus, the west coasts of Norway are precipitous, high and rocky; in the interior of Norway, the Lapland Alps present a precipitous west side, and the east shelves away, forming extensive plains. It is also very remarkable in the continent of America; where we observe several of the largest rivers, as St Laurence, La Plata, and the Amazons, running nearly from west to east.

Another observation may be made with regard to the hills; that is, that they all run in the longest direction of the islands in which they are placed. This is a general rule to be observed over all the globe. Thus the mountains in Britain run from North to South, the Scandinavian mountains follow the same direction, as also the great ridges of the Norwegian and Swedish alps. In America, the long extended chain of the Andes runs from North to South, which is the greatest length of the continent.

The

The hills have seldom the strikingly rugged aspect of those in the island of Arran, being greatly lower, and not so much worn by the rains and torrents; the principal effect of the Shetland scenery being that produced by the action of the waves upon the sea coast.

The hills are generally round backed, running in ridges; some approach to the conical, and are detached. None are remarkably high; as the highest, which is Ronas Hill, is only about fifteen hundred feet above the level of the sea.

To make general observations upon the climate of a country, requires a long and careful series of observations, with a multiplicity of apparatus, which few have an opportunity of obtaining. A good deal however may be done by means of careful observation with the thermometer and barometer; but even the proper use of these requires no common share of skill. To the exertions of the celebrated Mr Kirwan of Dublin, we are indebted for a great deal upon this subject; with a liberality that characterises a great mind, he has at great expence distri-

distributed meteorological instruments through Ireland, and we are now beginning to see the good effects of such endeavours. In this distant quarter of the globe no accurate register of the weather has been kept, so that all I can do, will be to make a few general observations, which nearly apply to all the Northern Isles of Britain.

The weather is extremely variable, being much incommoded with rains and thick fogs; which occasion many vessels to be wrecked on these terrible shores. During the winter there are considerable falls of snow, which lies but a short time, on account of the vicinity of the sea. The frosts which are seldom severe, and never long, produce little inconvenience; but were they to continue for any considerable length of time, it would be heaping horror upon horror, and would render a situation already dreary, comfortless. Frequently, during the winter, dreadful storms prevail, particularly from the west, which are accompanied with thunder and lightning; an appearance seldom observed at that season in other parts of Britain.

The

The aurora borealis, or what are usually called streamers, illuminate the sky with uncommon brilliancy, and help greatly to alleviate the gloom of the long winter nights.

CHAP.

CHAP. II.

MINERALOGY OF THE MAINLAND.

THIS is by far the largest of the Shetland islands, being about seventy miles long, and from twenty to half a mile broad. So great a difference of breadth naturally suggests an enquiry into the cause, which we discover to be the Atlantic Ocean, whose powerful tides and waves demonstrate in awful characters its stupendous operations. In some places it has carried away great portions of land, connecting the remainder by narrow necks to the Mainland; in others it has acted more equally, forming long narrow tracts connected to the Mainland by short isthmuses. Thus at Mavisgrind, the mountainous parish of North Mavin is connected

ned to the mainland by an isthmus about half a mile broad ; a similar appearance occurred in the parish of Æthsting ; and at Quarf, the long narrow tract comprehending the parishes of Dunroffness, Sandwick, and Coningsburgh, is joined to the mainland by an isthmus about two miles broad.

The cliffs around the whole island are very rugged, but more so on the West than the East side, and the bays or voes, islands and rocks, are also more numerous on the West than on the East coast.

There are few mountains of any considerable height, being generally from a thousand to fifteen hundred feet high. Few of them are unconnected, but generally run from North to South in the form of chains, having round-backed summits, approaching more or less to the conical form. Several considerable ridges can be traced along the whole of their course, and of these the most remarkable are the following :

1. CLIFF HILLS. This range commences opposite to the island of St. Ranens, where it is of

B
considerable

considerable height, running by Scalloway to Deal Voe, and from that to the sea, where it becomes gradually lower.

2. This range (which has no particular name) rises from Westshore, runs South West and North East to Lunnefting, terminating on the sea-shore ; with little variation of height.

3. This range rises upon the East side of Weefdale Voe from Buneness, and runs from sixteen to eighteen miles, terminating on the south side of Deal Voe in the parish of Delting.

4. This range, which is the highest, rises from the West side of Weefdale Voe from Rustaness, and terminates at Firskiness in Delting.

Having now mentioned the principal ranges of hills, and other preliminary facts, I proceed to the consideration of the mineral history of the island in particular ; but previous to this I shall make a few remarks upon the plan I mean to adopt. In writing the mineral history of any country, various plans have been followed ; but these usually de-
pend

pend more upon the degree of information the author is possessed of, than a predilection for any peculiar species of writing. Thus a thorough examination of all the strata of a certain district, their peculiarity of form, situation and composition, is best detailed in the form of a history; whereas a superficial and less satisfactory examination is usually related in the manner of a journal. Of mineralogical histories, however, there are but few, excepting some disquisitions by German authors; nor is this to be wondered at, considering the infant state of the science, and the great labour attending investigations of this kind. It is not sufficient that we observe a stratum as we pass along, and remark its appearance again in some distant quarter; but we must trace it from its commencement, through all its various turns to its termination, ascertaining at the same time its connection with others, their mutual gradations, with many other general and particular observations, which require a long and careful investigation. On the other hand, Mineralogists, in travelling through undescribed countries, have given much useful and interesting information in the form of a journal; thus Saussure, Charpentier, Ferber and others, have

in this way detailed a great number of facts, and diffused a very considerable taste for enquiries of this kind.

In the Outline I am now to give of the Shetland islands, and the island of Arran, I find it convenient to follow nearly the method of a journal, as best suited to the general view I am to take.

The Mainland is divided into several parishes, and some of them are of considerable extent; the parish of Lerwick, which gives name to the principal village in the island, is the smallest. This village contains about two thousand inhabitants, and is built upon the shore of Brassy sound, which is about the middle of the island. The houses in general are but indifferent; here and there, however, there are some commodious dwellings, and they are built of sandstone, and sandstone breccia, forming one street, which is terminated by Fort Charlotte. This fort was built during the time of Oliver Cromwell, and was for a long time in a state of ruin, until lately that it has been repaired at great expence, and

and garrisoned by a corps under the command of Captain —.

Brassay Sound, which is the harbour of Lerwick, is one of the most extensive and safe harbours in the British dominions, and has its name, and is formed in part by the island of Brassay. This island is about five miles long, and between two and three broad, but very irregular in its shape. It is high and rugged on the South and East, where it is much exposed to the action of the sea, but it is comparatively low on the West and North, where it forms part of the sound. The highest hill which is called the Ord of Brassay, forms, towards the sea, frightful precipices several hundred feet high, all composed of sandstone, flaty sandstone, sandstone flag and breccia, and the whole island is composed of the same materials. A great mass has been separated from the east side by the violent action of the sea, and forms what is called the isle of Nofs, remarkable for its tremendous cliffs and holm, where the natives encounter many dangers in fowling. This famous

mous holm* is separated about 34 fathoms from the isle, and is perfectly mural on all sides, so as to present a most terrific aspect when viewed from below. Inaccessible as it appears, it has not prevented the daring islanders from gaining its summit, which exploit was performed many years ago, by a dauntless fowler, who, having climbed to the top, drove stakes into the ground, and ropes being thrown around them from the opposite side, were fastened to corresponding stakes upon the bank of the island. A machine of wood, which they call a *cradle*, was then fastened upon the ropes, so that it could be pulled backwards and forwards, and in this way they go in quest of the numberless sea-fowl that inhabit these cliffs. The fowler who first planted the stakes, flushed with his success, would not take the advantage of the cradle; but braving every thing, attempted to descend, when he was dashed to pieces upon the rocks below. The island and the Holm do not differ from Brassay in their composition, being formed of sandstone, sandstone

* Mr Pennant in the elegant introduction to his Arctic Zoology, has given a drawing of Lows, which expresses the appearance of the Holm very indifferently. The holm is said, by Mr Pennant, to be about 480 feet in height; this is certainly too high.

sandstone flag, and breccia ; but the sandstone is of various colours, a considerable extent of the cliffs being of a reddish hue.

The opposite side of the sound where Lerwick is situated, is composed of the same sandstone and breccia, which we observe at Braffay. The Fort already mentioned, forming one extremity of the town, is built upon a rock of breccia, which soon disappears, when a horizontal stratum of sandstone takes its place, running to the opposite extremity of the town called the Nab. The hills in the neighbourhood are not high, and are composed of sandstone and breccia. This sandstone is the same we observe in all the other parts of the island. It is the Sympexium of Dr Walker, the Argillaceous sandstone of Mr Kirwan ; is of various colours, and of the usual hardness of common building stone. The breccia is a curious compound, being formed of red granite, micaceous schistus, quartz, felspar, and green mica ; the fragments are either rounded or angular ; of various sizes, from that of a grain, to masses of several hundred weight. The substramen or basis is hardly discernible, excepting when the masses
are

are large, when a paste is formed by the smaller fragments. I also observed in general, that where the fragments are large, the strata are distinguished with difficulty, and are horizontal ; but as the particles become smaller, the strata are more distinct and inclined.

The coast from Lerwick to Quarf is composed of sandstone ; in some places however, there are great rocks of breccia, which have a very singular appearance, owing to the immense size of the concretions. On this part of the coast there are several extensive caves ; we rowed a considerable way into one of them, then landed and walked to its further extremity. At the entrance it has the appearance of a natural arch, which becomes gradually lower until it is lost in darkness, where nothing is to be heard but the dropping of water from the damp black roofs, and now and then the silence is disturbed by the snorting of seals, or the flutter of the Pelicani or Columbæ. But the most beautiful part of these rocky scenes, is the wonderful transparency of the water, which discloses to our view, rocks of various fantastic forms, covered with the beautiful *Millepora rubra*, adorned with fuci

fuci of a great variety of colours. These by the gentle motion of the water discover numerous species of Spongiæ, Actiniæ and Echini, of the most exquisite colours, altogether forming an admirable submarine picture.

At Quarf, the island is only about two miles broad, forming the isthmus which connects the southern parishes with the Mainland, and is bounded on both sides by mountains of considerable height, composed of micaceous schistus. Here there is a small fishing station, from which boats go to the *Haafse*, or fishing ground, in search of tusk and ling.*

C

The

* The fisheries of this country, have been often the subject of discussion, but the state of the lower orders has hardly touched the heart of the traveller. It is foreign to my present purpose, but worthy of an abler pen, to set in a proper point of view, the miseries and the deplorable state of our countrymen in that quarter.

But Oh ! what crowds, in every land,
Are wretched and forlorn ;
Thro' weary life this lesson learn,
That man was made to mourn.

BURNS.

The land from this again becomes broader, forming one side of Æthvoe, and is all composed of sandstone, and breccia ; in several places, however, there are considerable strata of limestone, which is worked for building, and manuring the ground. This voe is a large open bay, having the flat and cliffs of Coningsburgh on the north and west, with Sandlodge, and Moufa on the south. The cliffs of Coningsburgh, which form part of the range of hills that rise opposite to St. Ranens, are composed of micaceous shistus,* of various species, more or less penetrated with quartz, having the sandstone lying upon it, which shows in a distinct manner the junction of the primary and secondary strata. In some places the sea has carried away the sandstone, and left the micaceous shistus exposed ; and where there
has

* The term Shistus has been much extended in its signification, particularly by a late celebrated Theorist, who includes, under this name, Gneiss, Micaceous shistus, Chlorite shistus, Hornblende shistus and Ardesia. This want of accuracy is to be regretted ; for it is plain, if such confusion be sanctioned, that the science of mineralogy will revert to the unmeaning jargon of a Sir John Hill.

has been an unequal action of the sea, the micaceous schistus is to be seen rising through the sandstone. This last circumstance has frequently deceived observers, particularly in their examination of strata, which have been exposed to the action of the waves of the ocean. Thus, at that interesting spot, Portsoy, we observe the Serpentine lying upon the Granite in a very distinct manner; but where the rocks have been much exposed to the action of the sea, considerable portions of the Serpentine have been carried away, leaving the projecting masses of Granite, sometimes in the form of great veins running through the Serpentine, or large masses seemingly lying over it.*

Amongst these rocks I observed beautiful specimens of the *Sapbare Dure*, a fossil which has been lately examined by the young Sauffure. It was immersed in a compact species of micaceous schistus, and presented the following external character.

C 2

Colour.

* These particulars are well marked in several beautiful drawings of Portsoy, in the possession of Lieut.-Colonel Emery.

Colour.—White, finely tinged with azure blue. The detached crystals reflect a silver white light, but not so bright as the Adularia, when a little decomposed.

Crystallization.—Is crystallized in the form of compressed prisms, intersected more or less with transverse sections, and presenting two narrow and slightly streaked, and two broad and smooth sides. The crystals are frequently disposed in a radiated form.

Cross fracture.—Striated and destitute of lustre.

Longitudinal fracture.—Foliated with a lustre like that of crystals, and metals not much polished.

Hardness—when struck parallel to its length, yields difficultly to the knife; when perpendicular to its length, gives fire with steel; scratches glass.

Specific gravity, 3. 618.

Becomes electrical by friction, and this electricity

city is negative. Saussure, in his excellent analysis found it to contain, in the hundred parts,

Argill,	55.
Silex,	29, 2.
Lime,	2, 25.
Magnesia,	2, 0.
Iron,	6, 65. †

Having passed these cliffs we come to Sand-lodge, one of the seats of the ancient and most hospitable family of Bruce, of Sumburgh, which is situated upon the sea shore; having a pretty extensive flat near it. At a little distance from the house, in the sandstone, which is here still continued, there is a vein of copper pyrites, or sulphuret of copper, which was worked for some time, by a party of miners, from Wales, with very flattering prospects; but the vein gradually decreased in width, until it was not above an inch broad, when it was thought proper to leave it. This ore afforded me eighteen per cent. of pure malleable copper, by assaying according to the

† Mr Herman in the *J. Chym. An*: 1793.—p. 394, describes a crystallized fappare, found in Siberia, which differs considerably, both in external and chemical characters, from this species.

the method of Eschaquart, or rather Gerhard.† On the opposite side of the house there is a large vein of iron ore, above six feet wide, having a very scorified aspect, and containing much manganese. It was also worked for some time, but the great expence, and the small proportion of iron obtained, soon caused it to be given up. The sandstone continues from this, all around to the bay of Sandwick, here and there intersected with calcareous spar, and much impregnated with oxyd of iron. Betwixt the Sandlodge and Sandwick bay, lies the small island of Moufa, or Queen island, about a mile and a half long, and upwards of a quarter of a mile broad. It is rather low, composed entirely of sandstone, and sandstone flag, with several strata of limestone, which run in the sandstone from east to west.

The whole coast from Sandwick to Sumburgh head, the most southern point of the island, is almost entirely composed of sandstone, and breccia, lying

† Kirwan's Mineralogy, vol. 2d. p. 373.

lying upon the mountains of Gneiss and micaceous schistus, which run through this part of the island; and also in several places there are considerable strata of limestone. From Sumburgh head, which is entirely composed of sandstone, we have an extensive and beautiful view of a great part of the Mainland, island of Brassay, and stupendous Noss; on the one hand the far distant Fair isle rises gently in the horizon, and on the other the secluded Fula forms a tremendous object. Below us we have a direful example of the blowing of loose sand or what is called the *Sand Flood*; for an estate which belongs to Sinclair of Brue is now rendered a forlorn waste, although, before this calamity, it was one of the most productive parts in the island. I could not learn the cause of this disaster, but it was probably owing to the tearing up some of the plants which are known to prevent the blowing of sand. This practice cannot be too severely reprobated, when it is known that the consequences are so pernicious; thus, in many of the Western Islands Dr. Walker has observed, that if the smallest aperture be made in the sand, the flood instantly commences; and we know that, in Suffolk, a quantity of sand, which at first only covered about ten acres, has

has now spread itself, and covers several thousand. The sowing of plants, which grow in loose sand, is the only remedy which can be recommended to stop the baneful progress of those floods, and of these several have been recommended, but the most efficacious are the *Galium luteum*, *Elymus arenarius*, *Triticum junceum*, and *Arundo arenaria*; this last the Dutch plant with great benefit. From Sumburgh head across the large open Quendal bay, little is to be seen, except a few rocks of an extremely coarse breccia, of the common kind. At the next head-land, Fitful head, the primary mountains make their appearance, without any covering of the secondary breccia or sandstone, which disappears at one side of Quendal bay, and is not to be observed again until we come to Sandness hill on the North West. This immense head-land is almost entirely composed of a lead-coloured micaceous shistus, of which the greater part is mica, in such minute scales as not to be distinguishable, but in forming large plates. In the fissures of the micaceous shistus I observed several small portions of micaceous iron ore, which for some time amused a party of miners with hopes of immense wealth. The micaceous shistus is here to be observed passing

sing to chlorite schistus, and intermixed with the talcite of Mr Kirwan, the lepis of Dr Walker, and considerable quantities of quartz. Below this at Garthness, there is a large vein of sulphuret of iron, about seven feet thick, running in a stone intermediate between micaceous schistus and chlorite schistus. It lies exposed to the day for twenty or thirty feet, and was worked for some time, but was so unproductive that it was soon given up.

The coast from this all along the west side by Bigtoun to Scalloway, including Colsa isle, and the island of Saint Ranens, is composed of granite, micaceous schistus, chlorite schistus, talcite of Mr Kirwan and quartz. The granite is by no means of the same species, but is considerably varied, of which the following descriptions will afford a sufficient proof.

1. **WHITE COMPACT GRANITE.** Is composed of white coloured felspar, quartz, with a few scales of green mica; the quartz and felspar are amorphous, and very closely connected, rendering the whole so very compact as to give the aggregate a nearly uniform fracture.

D.

2. **RED.**

2. RED COMPACT GRANITE. Is composed of red felspar, green actynolite, with a small proportion of quartz. The felspar composes about three fourths of the whole, forming altogether a very compact, hard, and not easily decomposable compound.

3d Species. Is composed of regularly crystallized rhomboidal red coloured felspar, with a small proportion of amorphous quartz, and mica in scales; forming an aggregate which is not so hard or compact as the preceeding species.

The island of Saint Ranens is but small, very rugged, and is connected to the Mainland by a bank of decomposed micaceous shistus. Captain Preston, in his chart of the Shetland Islands, has placed this bank at one end in place of the middle. The coast from this to Cliff Sound is very rugged, owing to its exposure to the Atlantic Ocean; but in the Sound the land is defended by the islands of House, Burra, and Trondray, and is neither rugged nor very abrupt.

The island of House is about three miles long,
narrow

narrow and flat, composed of micaceous schistus, granite and quartz. Near to the north end I observed a remarkable appearance, which although it may be common in other countries, I have seldom heard of. It is a vein of granite two or three feet wide, running in the micaceous schistus; the granite had the usual appearance, and where in contact with the stratified matter was not at all altered in hardness. This appearance has also been remarked by the celebrated Saussure whilst travelling in the Alps, in the neighbourhood of Mont Buet, also near the city of Lyons.* The late ingenious Dr. Hutton of Edinburgh, in his theory of the formation of strata, imagines that this is a proof of the posterior origin of granite to micaceous schistus. Such an explanation would answer well enough, if the previous steps of the theory upon which it is founded, were sufficiently incontrovertible; as this is not the case, we must still consider the granite and micaceous schistus of coeval formation.

The island of Burra, which is separated from the

D 2

island

* Saussure, Voyage dans les Alpes. Octavo edition, Vol. II. Sect. 599, 601.

island of House by a small sound, is also more rugged on the west, where it is much exposed to the action of the sea, and is composed of granite, micaceous schistus and quartz.

The coast and hills from Scalloway by Uistness Voe, Stromness Voe to Wisdale Voe, are composed of the usual alpine rocks. At Wisdale Voe there is a great stratum of limestone, which can be traced for several miles running in the micaceous schistus. All the hills in the neighbourhood are composed of micaceous schistus, talcite and gneiss; this last by decomposition forms a clay-like mass, which the inhabitants use for fullers earth. A great section of the gneiss is to be seen amongst these hills, where it is to be observed in various stages of decomposition.* It would be curious to determine with certainty, whether or not the disintegration

* The late Mr Wedgewood, upon analyzing an earthy substance from Sidney Cove, New Holland, was led from several circumstances to conclude, that it contained a new earth which he called Sydneia. Lately, however, Mr Hatchet, in an excellent paper read to the Royal Society of London, has demonstrated, in a most satisfactory manner, that this supposed earth is a compound of Silica, Argill, and Oxyd of Iron; and he supposes that it is derived from a decomposed granite, or gneiss, similar to what has been mentioned above.

gration of the gneiss depends on the decomposition of the felspar alone, or of the felspar, quartz and mica conjointly. From Weesdale through Æthsting and Sandsting, the alpine rocks continue, forming in many places considerable hills, and upon the sea-shore immense precipices of red granite. The scenery upon this coast is awfully grand; let us conceive to ourselves a great extent of coast, dreadfully rugged and broken, presenting to our view vast detached pillars, and numberless magnificent arches, through which the tides rush with inconceivable fury, and the whole being tinged with a reddish hue, produces a most terrific scene, when contrasted with the lurid appearance of a stormy sky.

The next parish, which is named Walls, I had but little opportunity of examining, so that I can say nothing with certainty of its composition. In the neighbouring parish of Sandness, the sandstone again makes its appearance at Sandness hill, which is of considerable height. From this the coast becomes gradually lower, where it is in many places peculiarly sterile and iron-like; the land again rises in height, and so on alternately all around

around the island, forming many considerable voes, with very magnificent pieces of scenery, particularly the Doreholm off the parish of North Maving, which is a vast detached rock, perforated by a great natural arch, very similar to some of those observed by Captain Cook amongst the South Sea islands. The immense rocks the Ofa, Skerries and Ramna Stalks, present a most frightful and tremendous appearance in stormy weather; but to particularize the many astonishing scenes that occur around this island, would be foreign to my present purpose. I shall therefore conclude this sketch by remarking that the rocks (as far as I have examined) are either granite, gneiss, micaceous schistus, chlorite schistus, or sandstone, but I did not observe this last in any quantity till we came to the East coast.

CHAP.

C H A P. III.

ISLANDS OF FOULA, PAPA STOUR, VEMENTRY, AND MUCKLE RHCOE.

FOULA.

THIS island is about three miles long, and half a mile broad, situated in the Atlantic ocean, about twenty-four miles from the Mainland, holding the same situation with regard to Shetland, as St Kilda does to the Hebrides. It contains but little level ground, being chiefly formed by three hills of a nearly conical shape; the highest of these being between eight and nine hundred feet. Here there is but one landing place, and in bad weather it cannot be approached. The east side which is much lower than the west, is composed of granite, micaceous
shistus

shistus, and quartz. The micaceous shistus covers the granite, but in some places the sea has washed it away, and left the granite exposed, which is of a red colour, and frequently penetrated with veins of quartz. The micaceous shistus also contains nests of green actynolite, and garnets are often diffused through it. The south, west, and north sides of the island are composed of sandstone, and sandstone flag, of the same species with that we have observed in other parts of Shetland. Upon the west side there are most hideous precipices, inhabited by numberless sea-fowl, which the inhabitants run incredible risks in catching.

The account which the excellent Bishop Pontoppidan has given of the fowlers in Norway, is realized and even exceeded by the inhabitants of this secluded spot. It is not many years since it was a common observation, that few died a natural death, being either drowned or dashed to pieces amongst these terrible precipices: now they are more cautious, and comparatively few are destroyed.

PAPA STOUR.

This island is of a very irregular shape, about a mile long, and one half broad, lying in the mouth of St Magnus bay, at a little distance from the shore of the Mainland. It is low, but one of the most fertile of the Shetland islands, and has several tolerable harbours, of which Hamna-voe, is the best; but the entry is difficult on account of a large ridge of rocks, which runs across the entrance. At House-voe, which is the usual landing place in coming from the Mainland, sandstone, sandstone flag, and breccia form one side of the voe, which is low and not rugged. In going round the island towards the next harbour, called Olis-voe, the sandstone soon disappears, when a fossil, nearly similar to Wacken presents itself, forming cliffs of considerable height without any marks of stratification, and it continues with little interruption all round the island, until it meets with the sandstone strata on the opposite side. From this it appears that these two genera of rock form the greater part of the island; several other fossils, however, are to

E.

be.

be observed, either in strata, below the Wacken in veins, or sporadic. Thus in some places it is penetrated with a species of Grunstein, which is composed of white felspar and basaltic hornblende. A few basaltic veins, or whyn dykes, as the Scottish miners call them, are to be observed crossing this rock, and decomposing so as to form a cellular stone, which the volcanists would have classed amongst the lavas. A singular species of breccia, not unlike that which constitutes part of the Calton Hill near Edinburgh, is to be observed running below it on the north side of the island. Veins of semi-indurated steatites, run through it in various directions, and these veins often contain hollow nodules of chalcedony or of red jasper, which are lined with crystals of quartz. Frequently also considerable veins of red sinople, intermixed with chalcedony, quartz, and rock crystal, run in this rock; and in one place in a fissure, filled with calcareous spar, I observed a few blue crystals, that appeared to be fluat of lime.

Having mentioned the principal sporadic and venigenous fossils, which are to be observed
in

in this Wacken, I shall now add a more particular description of it.

WACKEN, from Papa Stour.

Colour.—Brick red, of various shades, also dark brown.

Lustre.—None.

Fracture.—Smooth, earthy, but when compact has a tendency to the fine splintery.

Hardness.—It scarcely gives fire with steel.

Transparency.—None.

Fusibility.—Melted at 120° of Wedgewood.

It frequently contains felspar, forming a species of Porphyry; sometimes it is intermixed with the *Grunerde*. It often also contains cavities, which are encrusted with dark brown chalcedony, and covered with crystallized quartz; and nodules of Onyx, and Sardonyx are sometimes found in it.

I cannot dismiss this short account without mentioning, that various species of pumice are to be gathered in several of the voes of this island, and some of the pieces of very considerable size. Similar kinds of pumice are got near the Giants Causeway, in Ireland, and upon the shores of the Western islands, which Volcanists have reckoned a very satisfactory proof of their chimera. An examination of the rocks would soon satisfy any one but a volcanist that these were adventitious matters. Accordingly their origin is now plainly traced from the famous island of Iceland; and this is rendered the more probable, when we consider the many light substances floated from the West India islands, upon the shores of the Shetland and the Western islands.

VEMENTRY.

This island is situated in St Magnus bay, at a considerable distance from Papa Stour. It is much intersected by the sea, and rises highest in the middle, forming what is called the Wart of Vementry, upon the top of which there are the remains of a burgh. From this hill we have a view of the whole

whole island, and the adjacent coast of the Mainland, than which there can scarcely be a more dreary prospect.

From the short time I was upon this island, I can only say in general, that it appeared to be composed of granite, different kinds of micaceous schistus, and a beautiful species of hornstone porphyry, which I observed in various stages of decomposition; in some specimens the felspar appeared to be decomposed first, in others the hornstone.

MUCKLE RHOOE.

This island is about twenty-four miles in circumference, the east and south sides are low, owing to their being defended from the violent action of the sea by the Mainland, but the west side is very rugged and broken. From the little opportunity I had of examining it, I can only say that a considerable part appeared to be composed of granite. Another island in the same bay, called Papa Little, appears to be composed of granite and micaceous schistus, of various kinds.

CHAP.

CHAPTER IV.

THE NORTH ISLES OF SHETLAND, COMPREHENDING UNST, FETLAR YELL, AND WHALSET.

UNST.

THIS is the most northern of the Shetland islands ; it is about eight miles long, and from two to two and a half miles broad. Its form is that of a lengthened square ; the sea coast is as usual very rugged, and the island is hilly ; the highest hill which is named Valley-field, is about seven hundred feet. There are two excellent harbours, Balta and Uyea Sound, which are often of the greatest service in sheltering vessels that pass to and from the Greenland seas ; but the first is generally preferred as being more convenient and safe. Balta Sound is a pretty deep inlet, formed into an excellent

cellent harbour by the island of Balta that lies across its entrance, thus forming two passages ; one from the North is rocky and only fit for small vessels, but the other from the South will allow large ships to enter.

The hills upon the north side of this sound are of considerable height, but present a very bleak and barren aspect, owing to the decomposition of the serpentine, of which they are composed. This fossil by the action of the weather acquires an iron brown crust, and is often somewhat cancellated, so as to have much the appearance of a volcanic production.* The serpentine is of a green colour, is frequently traversed with small veins of iron ore, and often assumes a fibrous appearance, forming what Wallerius calls talcite ; a stone very different however from the talcite of Mr Kirwan. It also contains several curious sporadic fossils, of which the most remarkable are the following :

LAMILLAR ACTYNOLITE, Kirwan. Asbestartiger, Strahlstein of Werner. This corresponds with

* Ponces, 276.

with the specimen I examined in the Leskean Cabinet at Dublin, from which Mr Kirwan's description is taken. It appears to be an intermediate fossil between Actynolite or Strahlstein and Hornblende.

2. LABRADOR HORNBLENDE. This beautiful species was first observed upon the coast of Labrador, and afterwards in Germany, and since in Cornwall by Mr Hatchet.

3. Common or Striated TREMOLITE, Asbestinite of Kirwan.

Colour—Light green.

Lustre—Silky.

Transparency—A little at the edges.

Fracture—Broad striated, the striæ frequently diverging as from a centre. Its fracture also presents what may be called distinct concretions, and it is from these that the striæ appear often to diverge.

Hardness

Hardness—That which yields easily to the knife. By decomposition it acquires an iron brown crust.

Mr Kirwan found that this species melted into a green glass at 150° of Wedgewood; and Klaproth has lately found that in a coal crucible it gives a greyish white opaque slag, with a loss of 0, 05; and in a clay crucible a compact greenish white slag is formed, and he has found it to afford

Silex,	0, 65.
Lime,	0, 18.
Magnesia,	0, 103.
Carbonic acid and water,	0, 065.
Oxyd of iron,	0, 005.

The phosphorescence of the tremolites is very remarkable, and it has been found that the degree of effect is inversely as their hardness; thus the silky soft species gives a more vivid and red light, with a less degree of friction, than the harder kind; the phosphorescence can even be produced by means of a feather.

4. SHISTOSE TALC. Kirwan. Schieferiges Talc.
Lefke.

This fossil is to be observed in several parts of the island, running in the Serpentine in the form of veins of considerable extent. When long exposed to the action of the weather it loses its solidity, becomes friable and scaly, acquires a brownish colour and becomes opaque.

This Serpentine continues to form the hills and cliffs, until we arrive at the beautiful bay of Norwick, when a singular striated micaceous shistus takes its place, forming one side of the bay; this also constitutes a great part of the coast until a species of gneiss (remarkable for the large size of its crystals of felspar,) makes its appearance, the micaceous shistus which covered it being washed away. Near to this place an immense mass has been separated from the land, forming a great hollow called Saxen Kettle, from the sea rushing through a narrow aperture at the bottom, which causes it to boil up with great violence.*

The

* Here a Shetland Giant used to boil his prey, and terrify the affrighted natives; but more surprising than this is a famous well

The land from this runs out to form what is called the point of Lambanefs, equally steep, but not so high as the sides of the bay, and from this to the Sha, the most northern point of the island, and of his Majesty's dominions, the gneifs continues, and does not disappear until we approach to the deep bay of Bura-firth, where the land becomes higher, forming lofty cliffs of micaceous schistus. At the bottom of this bay the land is low, presenting beautiful rocks of undulated micaceous schistus†; but after crossing the bay we find the land rise gradually, forming the lofty cliffs of Hermonefs, which are composed of similar rocks. At the bottom of these cliffs there are immense caves excavated by the sea, into which a boat can row many hundred feet in calm weather; the entrance is said to be ornamented with regular octagonal pillars, but what their nature is I could not determine,

F 2

at a little distance, where the inhabitants say their ancestors used to get boiled or roasted fish, in proportion to the depth they went. This is a fact truly Plutonic, well deserving the attention of world makers.

† This species is entirely composed of mica without any admixture of quartz, which Karsten in his catalogue of the Leskean cabinet reckons a rare production.

determine, as the surf prevented me from approaching. Is it probable that they are formed of gneiss? for there is no other fossil near but micaceous schistus. From this the whole west coast is very lofty and rugged, composed of micaceous schistus, and this last often contains extremely beautiful regularly crystallized garnets of great size. As we approach the south west extremity, the land becomes lower, and towards Belmont, the seat of Thomas Mouat, Esq, of Garth, strata of Ardesia†, or primitive Argillaceous Schistus are to be observed in the neighbourhood of the micaceous schistus. The Serpentine now again makes its appearance and forms in several places considerable hills, which have as usual a barren and bleak aspect. On the sea shore, between Uyea Sound and the castle of Mounis, there are strata of sandstone; and from this to Balta Sound the hills and shores are low, formed of micaceous schistus with a compound rock of green hornblende and quartz,

† It is much to be regretted, that authors will not consent to use a fixed generical name to express the primitive Argillaceous Schistus, in opposition to the secondary schistus. The term Ardesia, proposed long ago by the great Linnæus, will answer very well; but it appears to be little attended to.

quartz, and in some places we observe rocks of a compact felspar with hornblende.

FETLAR.

This island is about four miles long, and three and a half broad, of an irregular shape, owing to its being much exposed to the action of the sea. Its mineral productions are not very different from those in Unst; indeed it is probable that at one time they were joined. There are no harbours of any consequence; the bay of Tresta is one of the largest, but is not safe in stormy weather. One side of this bay is composed of micaceous schistus, quartz, with strata of alpine or primary limestone. On the opposite side of the bay there are appearances of plumbago; in one place particularly there is a vein of a matter resembling an impure plumbago, which is between two and three feet wide, running to all appearance in micaceous schistus. This latter fossil forms the coast for a considerable way. It however disappears, when immense cliffs of serpentine are to be observed, which often afford beautiful masses of
rock

rock crystal, also fine specimens of asbestos and amianthus. The serpentine, having formed a considerable extent of cliffs, disappears, when a curious species of micaceous schistus presents itself, which is formed of rounded masses of quartz of considerable size, connected by means of mica, thus forming what has been called a primitive breccia. Saussure, in the 20th chapter of his *Voyage dans les Alpes*, describes a nearly similar rock, which he observed in the neighbourhood of Valorsine, differing from this, however, in having what he calls a schisto-micaceous base, and containing besides quartz, schistose granite, and micaceous schistus. This curious rock forms a considerable extent of cliffs, but at Strandburgh a micaceous schistus takes its place, which resembles hornblende slate in its general appearance, but its softness affords a sufficiently accurate distinction. This micaceous schistus also forms a considerable extent of coast, which is low, presenting a most splendid appearance when the sun shines, his rays being reflected from the micaceous rock as from immense mirrors. As the coast rises the Serpentine again makes its appearance, having
the

the usual brown, iron-like aspect, and forming lofty cliffs upon the shore; but these continue only for a short way, when the micaceous shistus is again to be observed, and continues forming low cliffs to the House of Urie. From this round to the bay of Tresta the coast is lofty and precipitous, formed of micaceous shistus; but at one place there are immense cliffs of gneiss, which by decomposition form a matter similar to that observed at Weesdale Voe, which is here also used as fullers earth,

YELL.

This island is about four miles from the Mainland, is about sixteen long, and eight broad, and is next to the Mainland the largest in Shetland. There are several harbours, but none of them large or commodious. It is in general pretty hilly, very much covered with peat mosses; this with its tremendous broken coasts, render the island wild and gloomy. The hills, as far as I could determine, are composed of granite, micaceous shistus, and quartz. On the west side, which is extremely broken and rugged, there

there are several curious veins of granite, between five or six feet wide, that run in the micaceous schistus. They are sometimes much curved, but generally run at an angle of about 70° .

WHALSEY.

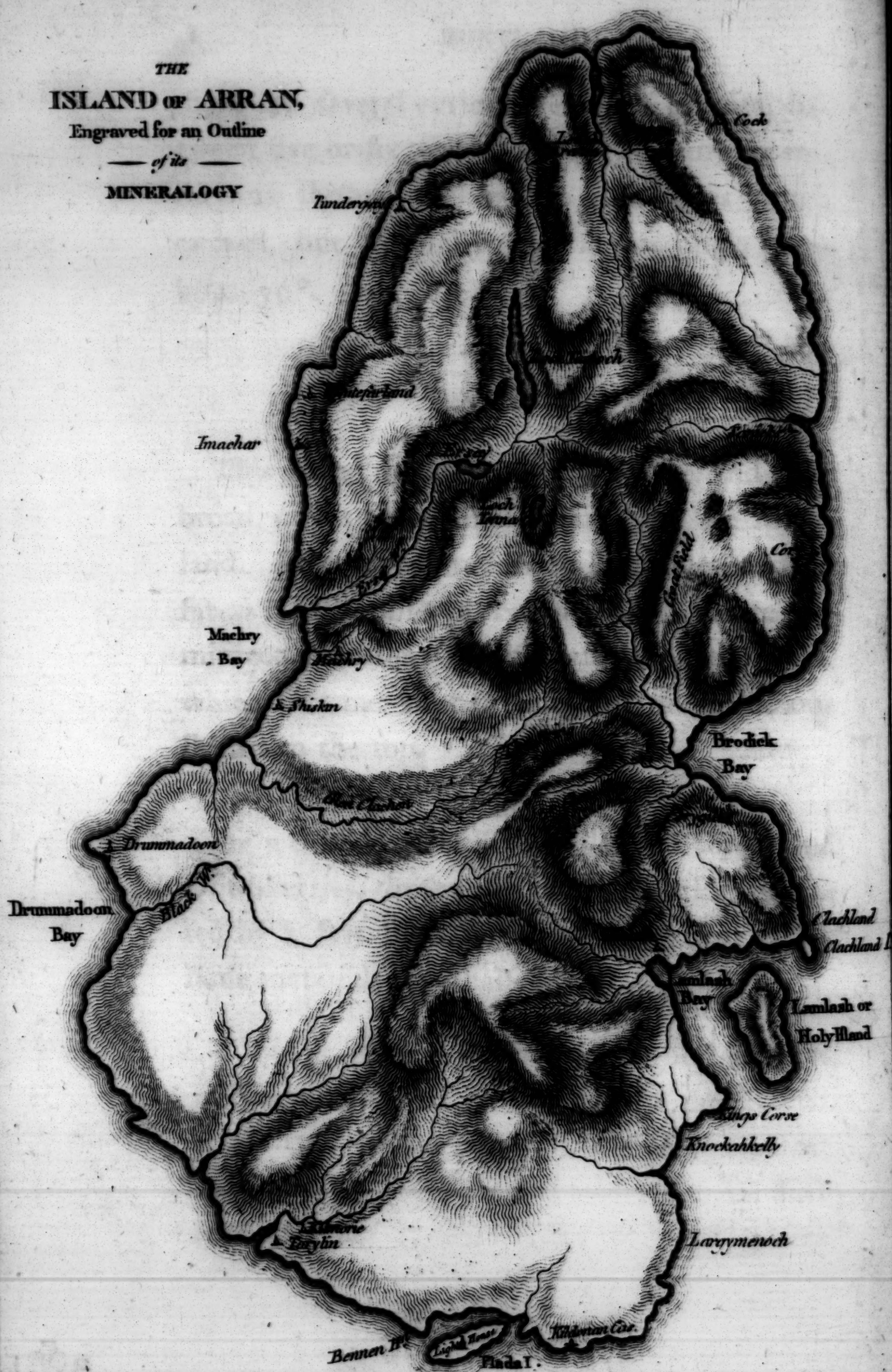
This island is about six miles long, and four broad, and is three miles distant from the Mainland. The shores are low on both sides, and, as far as I could observe, composed of granite and micaceous schistus; the highest hill is the Wart, which I found to be composed of micaceous schistus to the top.

At a considerable distance lies the Grief and Out-Skerries, dreary and desolate rocks, inhabited by a few fishermen, and composed of the same materials as Whalsey.

ARRAN.



THE
ISLAND OF ARRAN,
Engraved for an Outline
— of its —
MINERALOGY



ARRAN.

CHAP. I.

SIZE AND SITUATION OF THE ISLAND, CLIFFS, MOUNTAINS, SURFACE, &c. BRODICK BAY AND ITS ENVIRONS COMPREHENDING CORT-GILLS, GLEN-CLOT, GLEN-SHIRREG, GLEN SHANT, GOAT-FIELD AND GLEN-ROSA.

THIS island is about thirty-two miles long and twelve broad, situated in the mouth of the Frith of Clyde, about eight miles from Bute, and sixteen from Saltcoats in Ayrshire. Its shape is irregular, but not so much so as many of the Western Islands, which are more exposed to the Atlantic Ocean; here the vicinity of the Scottish and Irish shores prevents any great destruction of land, as is evident from the lowness of the cliffs round

G

the

the island, which have not the precipitous, rugged, and bold aspect of the Shetland Islands.

CLIFFS. The cliffs are seldom above two hundred feet high, are generally precipitous, having frequently, however, an intervening bank between the cliff and the sea, formed by the destruction of the rocks, which are either of sandstone or micaceous schistus. Considerable sandy beaches frequently occur, formed of the debris of granite, sandstone, and micaceous schistus, and sometimes we remark a considerable extent of coast, covered with enormous masses which have been torn away by torrents, or separated from the neighbouring rocks by the vast expansive power of frost.

MOUNTAINS. No regular ridge of mountains is to be observed; these being either in the form of groups, as Goatfield and the adjacent mountains, which present astonishingly grand peaked summits; or irregular, forming round-backed hills, as those towards the south part of the island.

SURFACE. The land is in general very high, particularly towards the north-end, where the
wonderful

wonderful group composed of Goatfield, Cairn-na-callich, &c. present mountains near three thousand feet high. Here nature exhibits to the astonished eye the most terrific and sublime scenery; to convey even a faint idea of which would require an able pen. The southern parts are lower, and in place of the bare rocky appearance of the North, we have heath-covered hills, and a considerable portion of cultivated land.

The island is divided into two parishes, Kilbride and Kilmory, belonging to three proprietors; the Duke of Hamilton, Marquis of Bute, and John Fullerton, Esq. of Kilmichael; and yields about 5000*l.* of yearly rent. This indeed might be much encreased were proper methods of cultivation followed; and were long leases and larger farms properly granted, more happiness, industry and wealth would be the natural consequence.

In describing the island particularly, I shall begin with *Brodict Bay*, which is situated on the east side. This beautiful bay is bounded, on the south, by the hills of Cory-gills; on the west, by the vales Glencloy, Glen-sherrig, Glen-shant; and on the

South, the tremendous Goat-field forms a lofty boundary. It is of an irregular shape, about five miles long, and four deep, having about five fathoms water, with good anchorage ground; but it is only in moderate weather that vessels can ride in safety. From this bay passage boats go to Saltcoats, about sixteen or eighteen miles distant, which renders this the principal thorough-fare in the island; so that the population is considerable. Many visitors come from the mainland, during the summer months, to enjoy the free air, and admire the wonderful scenery of this interesting island;—but the want of a good inn is much to be regretted. On the north side of the bay stands Brodick Castle, an old ruinous building, inhabited occasionally during part of the summer by the Duke of Hamilton. It is situated upon the side of Goat-field, commanding a most extensive and delightful prospect, and might easily be made one of the most beautiful seats in Scotland. About two miles distant, in Glencloy, is situated the pleasant seat of the ancient family of Fullerton, of Kilmichael; where the truest hospitality, joined to the most attractive manners, leave the stranger only to regret his departure from so much happiness.

Mi-

MINERALOGY.—The mineral history of this part of the island is, in many respects, interesting; not only on account of the variety of fossils which it affords, but also in presenting to us, in a short space, a representation of the structure and materials of nearly the whole island. On this account I shall be minute in my description, as I may have occasion to refer to this particular part, when describing some of the other quarters of the island.

The south side of the bay is low immediately upon the shore, it however rises gradually; forming the hills in the neighbourhood of Cory-gills, and towards the sea, cliffs of considerable height, almost entirely composed of sandstone *. This sandstone is pretty compact, of a reddish colour, much resembling that found in Shetland, and is here and there

* A curious observation with regard to sandstone, has been lately made in Germany. In the sandstone quarries, if the loose stony and sandy matter be left undisturbed for some time, the stones are found covered with a transparent filiceous crust, and the particles of sandstone are cemented by a similar filiceous matter. There, then, we have a most decisive proof of the solubility of the filiceous earth in water. Dr Hutton and his followers, deny the solubility of this earth in water, and carry the point so far as to disbelieve

there alternated with strata of breccia, composed of rounded fragments of quartz, with fragments of sandstone, of various sizes and shapes; and both these strata run at an angle of from 10 to 15°. In many places there are very considerable veins of basalt, or what have been called whyn dykes, * crossing the sandstone in various directions. Some may be observed rising from the sea, and penetrating the sandstone. In other places, where the superincumbent sandstone has been completely carried away, veins, can be remarked running with little variation, in diameter or direction, for nearly a mile

believe the petrifying power of Loch Neagh, in Ireland. A fact lately observed in Germany shows completely the futility of such an opinion: a wooden bridge, built upon the Rhine in the time of Julius Cæsar, was lately demolished, when the lower part of the stakes were observed to be *silicified*.

* This term, like many other popular denominations, does not convey a distinct idea of any particular genus of fossils, but is used by the inhabitants of Scotland, and the north of England, to express those fossils which are of *Basaltic formation*. Mineralogists in many instances appear to have used it in a very vague manner; thus some describe Trap, others Basalt; and not unfrequently Grunstein, and indurated clay have been arranged under this name. It is much to be wished that it could be entirely laid aside, particularly when we perceive that the great Werner has framed satisfactory characters for these different rocks.

mile. These veins are not only to be observed upon the sea shore, but can be traced running in various directions, and of different diameters, thro' the sandstone and other rocks, in the interior of the island, as we shall afterwards clearly demonstrate. In ascending the hill towards the Cory-gills, a very considerable vein of dark green pitchstone makes its appearance, running from the cliffs upon the shore, through the sandstone, to the Lamash road, where we soon lose it amongst the sandstone in the neighbouring hills. This vein is of various breadths; in some places, as at the Lamash road, being about eight feet. It does not appear to have altered the sandstone, where it is in contact with it; but in some parts of the vein, the pitchstone, as it approaches the sandstone, loses much of its lustre, and, in fracture and hardness, approaches to the nature of basalt. Higher up above the houses of Cory-gills, we observe a number of columns, which are composed of wacken-porphry. These pillars are in various directions; some are perpendicular to the horizon; others more or less inclined; and, what is singular, we find, further up, that they are quite horizontal. They are in the form of four or six-sided columns, from six to
ten

ten feet long, and two or three feet in diameter, having a whitish crust from decomposition. They are not jointed, nor is there any appearance of balls, or what the volcanists call *volcanic bombs* ! I endeavoured to discover the relative position of the sandstone and porphyry, but could not detect them in contact with each other, nor could I draw any probable conclusion as to their relative position. In descending from this porphyry hill towards Lamlaish, the sandstone again makes its appearance, but is soon lost, being covered with grunstein, which forms the summits of several hills in the neighbourhood, and may be remarked running towards the sea, forming cliffs. In one place we observe a great body of green-coloured pitchstone, which runs quite in an opposite direction to the vein we observed crossing the Lamlaish road ; in short, it appears to be stratified, and to run immediately below the grunstein. About twenty yards lower, another mass occurs about ten or twelve feet thick, and which, as far as I could determine, appears to form a stratum running between the sandstone and grunstein.

Having

Having now mentioned the position of the veins and strata, upon the south side; we shall return to the sea shore, where we observe the bay rising towards the west, forming the one side of Glen-Cloy.

GLEN-CLOY. This glen is nearly three miles long, and half a mile broad; open towards the east, but bounded on the other sides by high hills. At the top, or west part of the glen, the hills are highest, forming a very romantic groupe of rocks. The north and south sides, which are of considerable height, become gradually lower as they approach the sea, where they form part of Brodick bay. The bottom of the glen rises gently from the sea, forming a small angle with the hills that bound it. Immediately under the peat-moss or heather we discover boulder stones, which form horizontal beds, from three to thirty feet thick, and in other places they are collected together in heaps, being thrown into this form by the force of water. These boulder stones are not of very considerable size, and vary but little in that respect at the top or bottom of the glen; which shews that the greater part of them have not received

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ceived their rounded form by attrition in the water of the glen, but are derived from a decomposed breccia. They consist of granite, porphyry, scenite, breccia and sandstone, which are all to be observed in the neighbouring hills. Through the glen runs Glen-Cloy burn, formed by the springs and rains from the hills; it is narrow, but, during violent storms, it overflows a considerable part of the glen, and has thus laid bare the rocks, and shows us in a satisfactory manner the nature of the subjacent strata. The bottom of the glen is composed of the common red coloured argillaceous sandstone, and here and there are strata of breccia, and both are traversed with veins of basalt, which run in very various directions, and are from three to twelve feet in breadth. These veins, in their passage through the strata, (to use the Huttonian language) do not appear to have occasioned in them any alteration with regard to hardness; on the contrary, we often find a species of semi-indurated clay interposed between the sandstone and basalt. The hills on the north and south sides of the glen are of the same height, and the pente of the hills appears to correspond pretty nearly with the elevation of the strata.

The

The hills on the south side are formed of sandstone and breccia, which, towards the upper end, form very lofty precipices; many veins of basalt traverse the sandstone, and loose nodules of a singular species of black pitchstone lie scattered here and there. On the north side, near to Brodick wood, a very considerable vein of green coloured pitchstone (much resembling that at the Lamash road) makes its appearance running through the sandstone. In ascending the hills upon this side, after gaining a considerable height, the sandstone disappears, when a wacken-porphry is to be observed, and, upon the brow of the hill, where the rains, &c. have made a section of the strata, we observe several curious phenomena. In the first place, we remark the great tendency which the porphyry has to assume the columnar form; in some places they are pretty distinct, as at B;* but in others they are not to be observed as at A. The next appearance which claims our notice is the remarkable position of the basaltic veins, which run in various directions through the sandstone and porphyry. One great vein, C, is very striking. It is seen rising from the

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neigh-

* See Plate.

neighbourhood of the sandstone strata penetrating the wacken-porphry, and as it rises upwards getting a considerable curve; when it branches, one branch rises to the top of the hill, the other runs but for a short way into the porphry in the form of a wedge. Near to the same place another vein of basalt, D, is to be observed, running in an almost opposite direction, terminating in a wedge form; but, what is singular, we find intercepted between the porphry and the vein, on its upper side, a sandstone breccia, and on the lower a hard siliceous sandstone. The west or upper end of the glen is formed of sandstone, pretty much traversed with veins of basalt, which are more or less inclined and of various diameters. Besides this sandstone we observe lofty precipices of scenite, which form strata elevated at an angle of about 30° . This rock is not only very much varied in the nature of its constituent parts, but also in the degree of the intimacy of combination, which renders it very difficult to determine its different species. It is also penetrated with veins of basalt, but not so much so as the sandstone.* It forms
the

* Dr Hutton, in his speculations upon the Theory of the Earth, remarks, "If it be by means of heat and fusion that strata have
been

the higher part of several of the hills betwixt the top of this glen and the Shiskin, and is all along penetrated with basaltic veins.

It appears, from the description which has been now given, that the sandstone forms by far the greatest part of the glen; the next in proportion is the porphyry, and lastly the scenite.

No subject is more interesting or useful, than an examination of the relative position of strata and veins; in short, upon this is founded all our knowledge of geology. It is, however, attended

“ been consolidated, then, in proportion to the degree of consoli-
 “ dation they have undergone from their original state, they should
 “ *cæteris paribus*, abound with more separations in the mass. But
 “ the conclusion is found consistent with appearances. A stratum
 “ of sandstone does not abound so much with cutters and veins as
 “ a similar stratum of marble, or even a similar stratum of sand-
 “ stone that is more consolidated, they are in general intersected
 “ with veins and cutters; and in proportion as strata are deep in
 “ their perpendicular section, the veins are wide, and placed at
 “ greater distances.” This does not appear to be consistent with
 fact, for it is to be observed in Arran that the sandstone contains
 more veins than the scenite, which last is greatly harder than any
 sandstone in the island, and we observe that the scenite contains a
 greater number of veins than the granite, although it be softer
 and less compact.

tended with great labour and difficulty, not only on account of the many turnings and superposition of strata, &c: but also from the frequent impossibility of tracing these strata in such a manner as to convince us of their relative position. This last circumstance prevented me from determining, with sufficient accuracy, whether the porphyry lay upon the sandstone, or the sandstone on the porphyry; one fact inclined me to suspect, that they were both formed at the same time, and that the porphyry lies upon the sandstone. It was the remarkable vein of basalt, C, rising from the bottom of the glen, through the porphyry, which led me to presume that the sandstone and porphyry were formed at the same time; the vein appearing to rise through the sandstone and to penetrate the porphyry in the same direction. We have more certainty with regard to the scenite, which appears to be of an origin anterior to the sandstone, as is pretty well shewn from the appearance of a breccia that lies upon its surface, which had been interposed between it and the sandstone, before the causes which formed the glen had carried away the sandstone.

GLEN

GLEN SHIRREG. This glen is of considerable extent, bounded upon the one hand by Glen-Cloy, and on the other by Glen-Shant. The hills towards the west are not so rugged as those at the top of Glen-Cloy; and both the bottom and sides are formed of the common sandstone, much penetrated with veins of basalt, but towards the south-west we observe the wackeporphry, which forms part of the rocks higher up than the sandstone, and is in fact, part of the mass we observed before in Glen-Cloy.

GLEN-SHANT. This forms the entrance into the tremendous Glen-Rosa, has Glen-Sherrig upon one side, and Goatfield on the other. On the south side, sandstone, traversed with veins of basalt, makes its appearance, but as we proceed up the glen it is lost, and micaceous schistus takes its place. On the other side a very little sandstone is to be observed at the bottom of the hills, and the whole of the upper part is composed of micaceous schistus of various species.

GOAT-

GOATFIELD. This mountain, according to Professor Playfair, is about 2945 feet above the level of the sea, and is reckoned the highest in the island. It rises pretty rapidly from the south side of Brodick bay, until we arrive at the region, where the micaceous schistus disappears. There is a kind of irregular plain, from which the mountain rises in the form of an obtuse pyramid, and is very precipitous, being entirely formed of granite. On the west, where it forms part of Glen-Rosa, it is extremely steep, which is owing in a great measure, to the want of micaceous schistus and sandstone; for wherever these occur, the declivity is less sudden. On the east side the pente is more gradual, marking according to the steepness, the presence of granite, micaceous schistus, or sandstone. It declines a little towards the north, but rises again, forming one of the boundaries of the rude Glen-Sanicks; it also forms the top of the bare, rugged, and sterile Cory-Glen, and the top of other two great hollows between the Cory-Glen, and Glen-Sanicks.

The

The lower part of Goatfield is composed of the usual red-coloured sandstone, and is traversed by veins of basalt; this continues for several hundred feet up the mountain, when it at last disappears, the micaceous schistus rises from under it, separated only by a stratum of breccia, thus shewing the junction of the sandstone and micaceous schistus. The micaceous schistus continues until we arrive at the plain formerly mentioned; but the side of the mountain is so covered with the debris of granite, micaceous schistus, &c. that it is only by the appearance of the granite in the neighbourhood of this plain, that we are aware of its existence, as the ascent is hardly more steep over the micaceous schistus than the sandstone, which is not generally the case; for we find, when the strata are not covered with debris, that the sandstone is far less steep than the micaceous schistus, and this last than granite. Even in this way, we have a kind of general rule, for judging of the nature of mountainous ridges: if they be peaked and very precipitous, we may presume that they are of granite; if they be less lofty and not peaked, but still somewhat approaching to the

conical shape, we may suppose them to be composed of micaceous schistus; and lastly, if we observe these skirted by lower mountains, with a trifling pente, we may conclude that they are composed of sandstone and limestone.

The pyramidal part of the mountain has a very sterile and wild aspect, being completely covered with loose blocks of granite, and destitute of all vegetation, excepting a few lichens, which only add to its rude appearance. These blocks differ very much in size, some being about twenty feet long, and generally of a quadrangular shape, and are so heaped upon each other, as to render the ascent very difficult. Having, however, gained the summit, we are well repaid for our labour, by a most extensive view of a wonderful diversity of country. To the northward we look down upon the peaked summits, and deep glens in the neighbourhood of Goatfield, whose arid and reddish appearance, suggest fresh to our minds the effects of a dreadful conflagration. Beyond these, the isthmus of Cantyre, the island of Isla, the lofty and dreary paps of Jura, the long mountainous ridges of Argyleshire,

Argyleshire, and the far distant mountains of Mull, which are faintly descried, present a view, rather to be felt than described. On the east, the well cultivated island of Bute, the firth of Clyde, the Cumbray islands backed with the beautiful coasts of Renfrewshire, form a most picturesque scene. Towards the south we have below us the lower part of the island spread out like a map, forming a singular appearance, of heath covered mountains, and cultivated glens: further distant, the charming coasts of Ayrshire, the shores and mountains of Galloway, as far as the Mull, the stupendous craig of Ailfa, rising from the bosom of the ocean; all delight the eye, and ravish the imagination. Lastly, on the west, the coast of Ireland, from Fairhead, to Belfast Loch, conclude the amazing view from this interesting height.

GLEN-ROSA. This very striking glen, situated upon the west and south-west sides of Goatfield, is about five miles long, and half a mile broad, bounded by very high mountains. The bottom forms a considerable angle with the sides, rising gradually towards the upper, or

north end, where it is formed partly by the mountain called Keid-vere, and partly by Goatfield. From this we view, on one hand, the glen in all its extent, on the other we look into the dreadful hollow of Cory-na-huave, and the long extended Glen-Sanicks, which runs from this, and forms an astonishing scene. The mountains on the opposite sides of the glen, are of different heights, (being far higher on the east than west) but the inclination of the opposite slopes is the same, being about 70° . The bottom and sides of the glen are formed of granite, similar to that of Goatfield, forming what I conceive to be immense, nearly vertical strata, which run nearly in the direction of the glen, which is north and south. These strata (if they may be so called) present from the bottom of the glen their flat surfaces, which are split in many places, into rhomboidal masses, so that we cannot perceive the marks of stratification until we mount up many hundred feet, when the edges of the strata are distinctly perceived running for a great extent, emerging here and there from below the loose blocks of granite, which have fallen from the top of the mountain,

tain, or have been formed by the splitting from the surface of the strata themselves.

La Metherie in the last edition of his *Theorie de la Terre*, speaking of the primitive mountains remarks : *
“ Les masses ne sont ni par bancs, ni
“ par couches, comme l’ont pretendu des fa-
“ vans naturalistes. J’ai parcouru une grand
“ quantité de terrains primitifs, et je n’y ai ja-
“ mais vu de couches. Quelquefois on apper-
“ coit des masses assez considerable de granits,
“ ayant une figure presque rhomboidal, super-
“ posés les uns sur les autres. Mais on ne fau-
“ roit regarder ces superpositions pour de
“ couches, puisqu’elles n’ont rien de regulier,
“ et que ces masses, presque rhomboidales, ne
“ se rencontrent que tres rarement. Le plus sou-
“ vent ces granites sont fendilles, en different
“ sens. Ces scissures se correspondent quel-
“ quefois ; ce qu’on prendroit au premier coup-
“ d’œil pour des especes des couches. Mais un
“ examen plus approfondi en fait bientôt recon-
“ noître la difference.”

From

* *Theorie de la Terre*, Tom. 4, p. 352.

From these observations, La Metherie does not appear to have observed the phenomena so well described by Sauffure, and which, as I presume, occur in Arran. What he describes are appearances which occur in almost all granite countries. The superposition of blocks of granite upon each other, could hardly be mistaken for stratification; the splitting of granite, however, is often apt to deceive, if the concomitant circumstances be not examined with sufficient attention*.

Upon the east side of the glen, several curious appearances are to be observed; of these the most interesting are the basaltic veins, which traverse the granitical strata, as they do the porphyry and sandstone. The first vein which I discovered, being between three and four feet in diameter, is to be observed rising through the granite, several hundred feet above the bottom of the glen; its lower part is hid by the heather, and loose blocks of granite, which cover the sides of the mountains.

As

* Dr Walker informs me that the granite in Galloway, is stratified, with such distinctness, that it is raised by the quarriers in immense flat masses.

As it rises upwards it becomes gradually narrower, and at last divides into two branches, which run through the granite, contracting and enlarging their diameter from a few inches to more than two feet. The extremity of one of these branches, appears either to have been broken, or so bent downwards as to cause one part of the branch to have the appearance of being separated from the other as is represented in the plate, where A is the granite, B the basalt vein, C the branch having the appearance of being separated from D by intervening granite. In the body of the great vein there is immersed a considerable wedge-shaped piece of granite, marked in the plate at E, which has the usual hardness, colour, &c. of that species of which Goatfield is formed. In some parts the vein is bounded by small grained compact granite, in others by the common granite of Goatfield. The granite and basalt are not intermixed at their junction, no matter is interposed, and they are not altered in the least by being in contact with each other.* In the neighbourhood of this
vein

* Mr Mills, in his account of some strata in Ireland and Scotland, detailed in the London Transactions for 1790, mentions the
appearance

vein I found specimens of rock crystal in cavities of the granite, and several other fossils. Amongst these the most remarkable was a species of granite much allied to the Pierre graphie, a fossil which is found at Portsoy in Banffshire, and in Siberia. Here I also observed specimens of the schistose granite adhering to the common kind, and also a granite, where the felspar, quartz, and mica, were distributed in a radiated form, as is the case with many zeolites.*

Near to the top of the glen, upon the same side, many fragments of basalt are to be observed, lying upon the sides of the mountains, showing the presence of basalt veins, and at the Keid-vore a great

appearance of a vein of basalt, or vein of lava as he calls it, about two feet wide, included in a vertical fissure of granite, ranging N. E. by E. and N. W. by W. in a small island in the sound of Jona in the Hebrides.

* Dr. Hutton imagines that this species of granite affords him a proof of the igneous origin of granite in general. It will be viewed otherwise, if we observe that it does not differ from the common species, but in the irregularity of the crystallization of its constituent parts; and it is plain that the felspar has impressed no figure upon the quartz, as the strata is an appearance characteristic of the most regularly crystallized rock crystal.

great vein is to be seen rising perpendicularly through the granite. Nearly at the same place, I was much surprized to find several masses of green coloured pitchstone lying amongst the debris of the granite ; but, after considerable labour, I was not able to detect its situation.

Not far distant from this, in ascending towards the summit of Goatfield, I observed, amongst the loose blocks of granite which cover its sides, a curious appearance. Upon breaking these rocks with an expectation of discovering rock crystal, I found in several of them masses of compact granite, of different sizes, either rounded or angular. Saussure mentions a specimen, in the possession of Werner, of a *granit-en-masse*, inclosing distinct *cailloux roulés*; which appears to be of the same nature with this.

The west side of the glen is formed in part by a granitical mountain, named Ben-echleven, which presents to us the great flat sides of the granitical strata ; its top is covered with enormous blocks of granite, which rest upon each other in a most fantastical manner. This mountain declines

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rapidly

rapidly towards the north-east, forming a tremendous hollow, named Cory-dain, whose bottom is far elevated above that of Glen-Rosa, but is lower than the bottom of the next hollow, named the Feun-hody, which is raised far above either, presenting to the bewildered eye an amazing scene of ridged and peaked rocks of granite. In the Cory-dain, the granite at first sight appears to be stratified horizontally; but an examination shews us that it is owing to the splitting of the granite. Here also we observe the granite disintegrating in the form of sand; and what is more rare, decomposing in the manner of some species of basalt; that is, in crusts. Saussure, speaking of this kind of decomposition, remarks, " Un autre fait, dont
" je trouvai la solution en examinant ces granits
" de près et avec attention, c'est celui de ces ex-
" foliations, que j'avois observées dans la vallée
" supérieure. C'est un fait connu de tous les mi-
" neralogistes, que la plupart des pierres sont plus
" tendre dans le sein des montagnes qu'à leur ex-
" terieur, et qu'elles acquierent à l'air un degré
" de dureté sensible. Il suit de là, que la partie
" extérieure, ou le bord de la tranche verticale d'
" une grande assise de granit doit se durcir par le
" contact

" contact de l'air, tandis que l'intérieur de la
 " même assise conserve un certain degré de mol-
 " lesse. Et tant que les assises inférieures de-
 " meurent un peu molles, le poids énorme de
 " toutes celles qui reposent sur elles, doit à la
 " longue les comprimer. Mais les parties exte-
 " rieures, durcies par le contact de l'air, ne sont
 " pas susceptibles de la même compression. Elles
 " doivent donc s'en séparer, et former ainsi les
 " exfoliations que l'on observe. *

K 2

CHAP.

* Sauffure, Voyages dans les Alpes, tom. VI. p. 318.

ARRAN.

CHAP. II.

DESCRIPTION OF THE FOSSILS, MENTIONED IN THE PRECEDING CHAPTER.

PITCHSTONE.

ARGILLA PICEA, Werner ; Obsidian, Dr Walker's *Classes fossilium* ; Pijfite La Metherie.

PITCHSTONE, from Lamlassh road.

Colour.—Dirty green, much the same with that from Brodick wood.

Lustre.—Like that of crystals, or metals not much polished. Is often beautifully iridescent,
and

and this is particularly the case at the thin edges of the splinters.

Hardness.—Gives a few feeble sparks with steel, but is very brittle.

Fracture.—More or less perfectly multiplied, conchoidal, or splintery.

Fragments.—Almost always in the form of four sided irregular columns.

Transparency.—Transmits a very little light at the edges.

Fusibility.—At 118° of Wedgewood's pyrometer it had intumesced a little, like zeolite, forming a porous mass of a whitish colour, intermixed with pink.

This species is often intermixed with one similar to that observed at Brodick wood.

PITCHSTONE, Brodick Wood.

Colour.—Dirty green, but the number of distinct concretions give it a light hue.

Lustre.—Greasy.

Transparency.—Transmits a very little light at the edges.

Hardness.—Gives a few sparks with steel.

Fracture.

Fracture.—Uneven, conchoidal, and sometimes splintery, with numerous distinct concretions. In the gross is often flaty.

Fusibility.—At 75° formed a compact glazed mass, coloured red and white. At 100° it forms a compact mass, having, however, in some parts the appearance of pumice*.

The different species of this genus have been found to differ considerably in their degree of fusibility, but in none so remarkably as the one now described. Mr Kirwan, who has made the most satisfactory experiments upon their fusibility, observed, that the most fusible formed an enamel at 130° , but in general were far more refractory, some refusing to melt at 160° . Widenman also found them to differ considerably in this respect. It will be difficult, then, to say with confidence, that either of the Arran stones belongs to this genus, at least, if we are to carry the character of fusibility

* The Abbé Spallanzani, in his travels through the two Sicilies, remarks, That Pumice cannot be formed from any kind of natural glassy substance; the fact mentioned above, renders this somewhat doubtful.

fusibility so far as Mr Kirwan has done in the case of the Gemeiner Kiesel Schiefer of Werner.

It decomposes by the action of the weather in the form of a white tegmen, which is often separable into layers. It is also frequently traversed with another species, which has a greater degree of lustre, and is more difficultly decomposable by the action of the weather; on account of this last circumstance, specimens of this kind, when decomposing, present a striped surface of dark green and white, the dark green being the undecomposed species. Gerhard, in his Mineral System, mentions a species of gneiss and granite, that contains obsidian, a stone much allied to pitchstone. Townson, in his travels through Hungary, remarks, that this gneiss is a species of obsidian, with black and white layers, containing also, probably a few crystals of adularia, and scales of mica. The stone I have now described, appears to be of the same kind, and this is rendered more probable from its sometimes containing felspar.

BLACK

BLACK PITCHSTONE.

South side of Glen-Cloy.

Colour.—Black.

Lustre.—Much like that of silk.

Transparency.—None.

Hardness.—Gives a few sparks with steel.

Fracture.—Uneven, with a slight tendency to the conchoidal.

Fusibility.—It begins to melt at 31° ; at 65° it tumescs very much, forming an extremely cavernous yellowish brown coloured mass, and at 100° it was less cavernous, and had more of a yellowish colour.

This fossil differs remarkably from the pitchstones, not only in fusibility, but also in external characters; it is therefore a question whether it should not form a distinct genus.

BLACK PITCHSTONE.

2d Species.

Colour.—Black.

Lustre.

BLACK PITCHSTONE

Specimen No. 1

Color—Black

Fracture—Like that of bit

Streak—Black

Hardness—Gives a few sparks with steel

Fracture—Uneven, with a slight tendency to

the conchoidal.

Specific Gravity—It begins to melt at 319° , at 629° it

melts very much, forming an extremely cavity

more yellowish brown coloured mass, and at 1009°

it was less cavernous, and had more of a yellowish

color.

This fossil differs remarkably from the pitch-

stones, not only in substance, but also in external

character. It is therefore a question whether it

should not form a distinct genus.

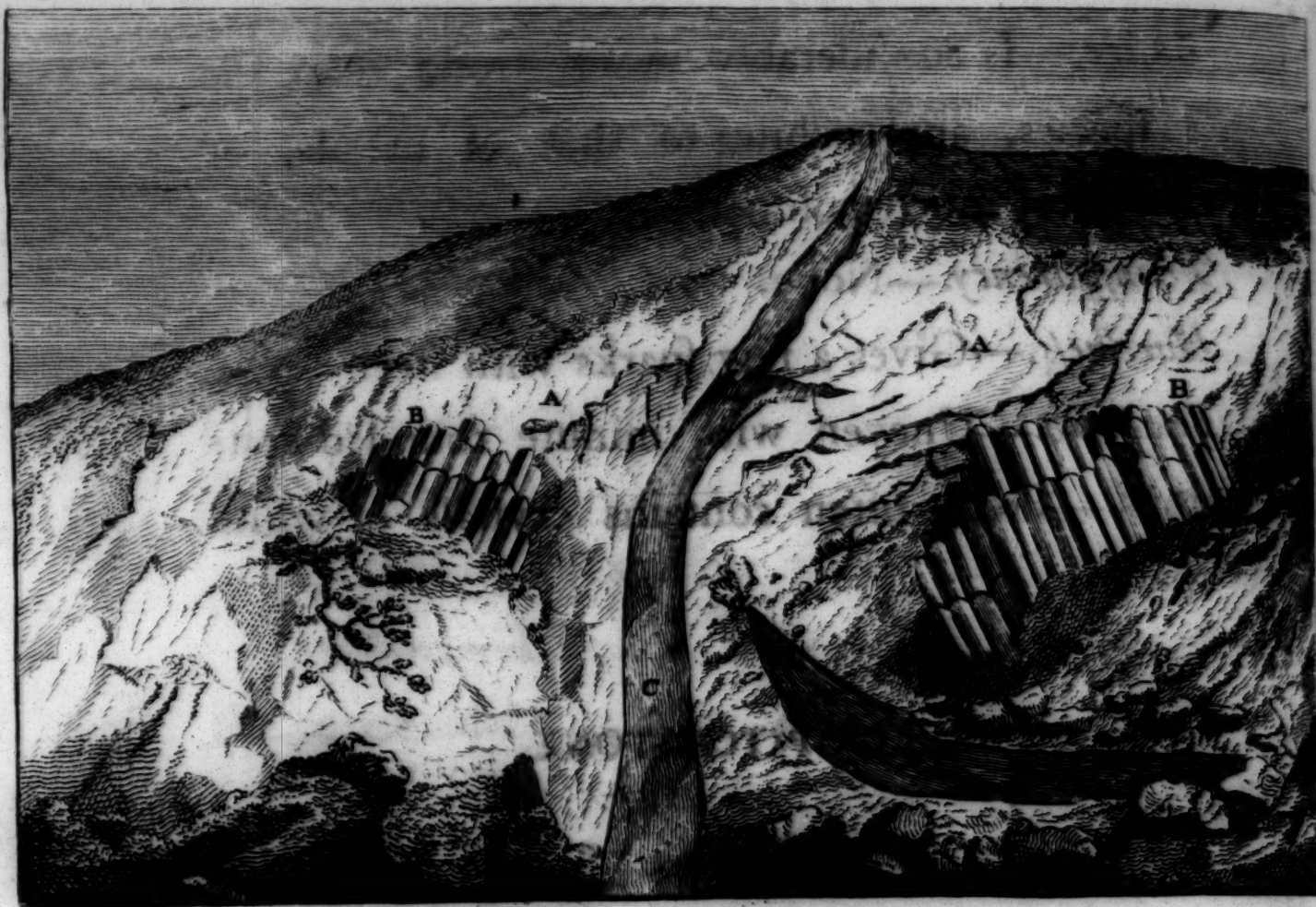
BLACK PITCHSTONE

2d Specimen

Color—Black

Light

NORTH SIDE OF GLENCLOY.



EAST SIDE OF GLEN ROSA.



Lustre.—Is considerably more strong than the first species, approaching to that of metals, or crystals not much polished.

Transparency.—None.

Hardness.—Gives a few sparks with steel.

Fracture.—Uneven with minute rounded concretions.—Pretty often contains crystals of white felspar.

BLACK PITCHSTONE.

3d Species.

Colour.—Blueish black, in other directions common black.

Lustre.—Like that of crystals, or metals not much polished.

Transparency.—None.

Hardness.—Scarcely gives fire with steel.

Fracture.—Uneven, with a tendency to the conchoidal.

Fusibility.—Formed a black cellular mass, at 47° and at 52° was more compact.

This species was found in the low island of Egg, one of the Hebrides, by Dr Walker; and is the
L only

only place in Scotland, where it has as yet, been observed.

These different kinds of Black Pitchstone appear to pass imperceptibly into basalt; a curious specimen of this kind occurred to me, in the neighbourhood of Kilmichael-House, in Glen-Cloy. One part is common black pitchstone, but it gradually loses its lustre, its fracture passes from the conchoidal to the plain splintery; then it gives a grey streak, is not at all fragile, in short is a fair basalt. Their great fusibility leads me to suspect, that they contain an alkali; which is likely pot-ash, as this kind of alkali has been found in various mineral substances, as the lepidolite, leucite, or Vesuvian garnet, lava, pumice*, and zeolite. If this should be found to be the case, it is not unlikely that it enters into the composition of the fusible species of basalt, particularly when we recollect, its gradation to black pitchstone.

BASALT.

* Dr Kennedy, of Edinburgh, in an excellent paper, lately read to the Royal Society of that place, has demonstrated the presence of pot-ash, in a considerable proportion in several kinds of pumice.

BASALT.

BASALT, Werner ; Common Trap, Kirwan.

Basalt, south side of Glen-Cloy.

Colour. Black.

Lustre. A number of shining particles dispersed through it, which are probably hornblende.†

Transparency. None.

Hardness. Scarcely gives fire with steel.

Fracture. Even earthy, but is very compact.

By decomposition acquires a brownish coloured tegmen.

BASALT, which forms a vein, running in the porphyry, head of Glen-Cloy.

Colour. Lavender blue, intermixed with yellowish green ; by decomposition, brick red.

Lustre. None.

Transparency. None.

Hardness. Yields pretty easily to the knife.

Fracture. Rather uneven fine splintery.

Fusibility. Melted at 103° .

L 2

Colour.

† Hornblende having been found to contain charcoal, or probably carbone as a constituent part, has been ingeniously mentioned by Dr Walker, as one fact, to show the transition from Plumbago to Hornblende, which he imagines he has observed in several other instances.

BASALT, which forms veins traversing the granite, east side of Glen-Rosa.

Colour. Greyish or black.

Lustre. A number of crystals of hornblende, dispersed through it, give it a slight degree of lustre.

Transparency. None.

Hardness. Gives a few sparks with steel.

Fracture. Uneven earthy.

Gives a grey trace.

Fusibility. Melted at 58° . This remarkable fusibility distinguishes it from the species of Basalt examined by Mr Kirwan. He found them fusible from 120° to 130° , and the figurate trap, or columnar basalt, melted at 100° .

It contains yellow coloured *Olivin*, but in greater quantity than I have observed in other species. The olivin does not occur in the basalt which traverses the sandstone strata.

SCENITE.

This rock, we have remarked, forming strata at the head of Glen-Cloy, and it occurs in many other parts of the island; we shall now mention its external characters. To prevent repetition, I will shortly detail the different species, placing the ingredients in their order of proportion.

1st Feltspar, reddish.

Hornblende, green and sometimes black.

Quartz, white and sometimes brown.

This species is more or less compact, and is sometimes shistose.

2^d, Hornblende, green.

Quartz.

Feltspar.

This aggregate, which is almost entirely composed of hornblende, has the following characters:

Colour—Dark green.

Lustre—A number of shining points dispersed through the mass, owing to the hornblende.

Transparency—None.

Hardness—Gives fire with steel, but not very plentifully. Leaves a grey trace. It is difficultly distinguishable from many species of basalt, and is often intermixed with patches of the first species.

3^d, Quartz.

Feltspar.

Hornblende.

This species, owing to the great proportion of quartz, has much the appearance of a sandstone.

4th, Hornblende.

Quartz.

Quartz.**Greenish coloured felspar.**

The hornblende in this compound, has sometimes a metallic lustre, approaching to the nature of schiller spar; and the felspar is tinged green, owing to the diffused matter of the hornblende.

PORPHYRY.**WACKEN-PORPHYRY from Cory-Gills.**

This species is composed of a basis which appears to be of the nature of wacken.

Colour—Brownish or light yellow, by decomposition acquires a white tegmen.

Lustre—None.

Transparency—None.

Hardness—Cannot be scraped with a knife, and hardly gives fire with steel.

Fracture—Uneven earthy, sometimes fine splintery.

FELTSPAR.

Is of a brownish colour, sometimes white and crystallized.

QUARTZ.

Is of various colours, white, yellow or smoke,
of

of different shapes, angular, rounded, or regularly crystallized, presenting here and there six-sided pyramids; it is also sometimes dispersed through the basis in the form of strings.

PORPHYRY, from Glen-Cloy.

The basis of the porphyry found in this glen, differs, in general, but little from that of Cory-gills; in particular instances, however, we observe a considerable difference of appearance, marking the gradations of the base, and the different proportions of felspar and quartz. In some specimens, the quartz entirely disappears; a few specks of felspar only remain, immersed in a basis which is more of the nature of indurated clay than of wacken. This basis is of a lavender blue colour, with an earthy fracture, without lustre or transparency, and yields pretty easily to the knife. Not unoften the porphyry is shistose, and frequently the shistose porphyry, or siliceous shistus of Mr Kirwan, is to be observed having the following characters.

Colour.—Grey, or greyish black.

Lustre.—None.

Transparency

Transparency.—Transmits a very little light at the edges.

Hardness.—Gives fire plentifully with steel.

Fracture.—In the gross, flaty; of the single plates, more or less fine, splintery, inclining to the even.

The felspar is seldom to be observed, but the quartz frequently occurs.

GRANITE.

The granite of this island is, in general, pretty compact, of a whitish brown colour, owing to the slight brown tinge of the felspar. To describe all the varieties that occur, might be useful, but that is more adapted for a systematic treatise of mineralogy, than an outline of this kind. I shall only, therefore, give a particular account of two species, the great grained, or common species, and the small grained.

1st. GREAT GRAINED GRANITE. This species is not only remarkable, by its forming a very considerable part of the solid materials of the island, but also on account of the peculiarity of its composition; as it frequently contains
three

three species of felspar, and the quartz is often crystallized.

1st Species, FELTSPAR.—Is of a white colour, with a slight tendency to the brown, having the usual lustre, transparency, fracture, and hardness.

2d Species ADULARIA ? Colour, White.

Form.—Either in amorphous masses, or crystallized in hexahedral prisms, bevelled at both ends.

Lustre.—External, like that of crystals not much polished. Internal, same.

Transparency.—Sometimes objects can be seen pretty distinctly through the crystals, but when they are a little decomposed, opacity is produced.

Fracture.—Plain foliated, and sometimes striated.

Hardness.—Gives fire plentifully with steel.

Fusibility.—At 100° the surface was formed into a yellow coloured enamel.

M

3d Species.

3d Species. Is of a white colour, having nearly the usual hardness, fracture, &c. of the common felspar, differing principally in the lustre, which is like that of polished metals, reflecting, in certain directions, a silver light.

QUARTZ. Is frequently colourless, also greyish, pale yellow, pale, or dark brown, and sometimes nearly black, when it is called *Mafion*.

Is very often crystallized, and either in the form of hexangular prisms terminated by hexangular pyramids, at one or both ends, and the prisms are seamed across. The crystals are sometimes found several inches long, and from two to three inches diameter, of a pale brown, or rather smoke colour. These last are much valued by the Lapidaries.

MICA. Is often black, sometimes golden yellow, tombac brown, or green. It is generally in the form of irregular plates; and pretty frequently hexagonal plates occur, which being superimposed upon each other, form a hexagonal figure, of some magnitude.

The

The constituent parts of the granite, are very various in their proportion ; but, in general, the felspar forms the most considerable part ; then the quartz, lastly the mica.

2d **SMALL GRAINED GRANITE.** Is very compact, with an uneven fracture, composed of felspar and quartz, in nearly equal proportions, with very few scales of black mica. It is subject to much variety, not only on account of the size of the particles, but also from the relative proportion of the ingredients, their degree of compactness, &c. Some varieties are so compact, and have such a general appearance, as easily to pass for sandstone ; but a careful examination of the figure of the particles, the want of substramen, or basis, and lastly, its situation in the earth, afford sufficiently distinct marks of difference. It is generally found in fissures, which traverse the great grained granite, in all directions ; but it also occurs in patches dispersed through the common species*.

M 2

MICA.

* It has been observed in the mountains of the Hartz, that granite affects the magnetic needle ; but it acts only in mass, and in a perpendicular vein—Detached pieces show no action upon the needle,

MICACEOUS SHISTUS.

SHISTOSE MICA, Kirwan; Lepidotis, Dr Walker; Glimmer Schiefer, German.

It would be tedious to describe the different species of micaceous shistus, that are to be found in this island. I shall, therefore, only make a few general observations. It is, in general, very compact, and often so much so, as to break into angular fragments, with little tendency to the shistose form. The mica is of various colours, but generally greyish; it also differs in its proportions; the scales are, in general, small, in no instance being so large, as in the generality of specimens, in Shetland. In some instances the scales are not distinguishable; and then it has a lead colour, and often verges towards Ardesia, particularly some of the species, in Glen-Halimidel, and Loch-Ranza. The quartz is also very various, not only in its proportion, but also in its colour and mode of distribution. When it is in considerable proportion, and very intimately mixed with black mica, it is difficult to distinguish it, at first sight, from some species of basalt. In no instance did

I observe hornblende, garnet, actynolite, sap-
pare, shorl, or calcareous spar mixed; but some-
times the talcerde of Werner, was intermixed
with the mica.

BRECCIA.

I have already remarked, that the common
breccia, which runs amongst the sandstone, is
formed of fragments of sandstone and quartz,
immerfed in an arenaceous basis. Another spe-
cies occurs upon the summit of the Scenite hills,
back from Glen-Cloy. It has an arenaceous
basis, approaching, in appearance, to basalt, and
containing rounded, or angular masses of granite,
fimilar to that of Goatfield, micaceous shistus,
quartz, porphyry, the same with that of Glen-
Cloy, basalt and hornstone. I was not able to
discover its real situation, but its composition
showed, that it was probably interspersed be-
tween the primary and secondary strata. The
circumstance of its containing granite, ex-
plained a phenomenon, which long puzzled me,
the appearance of rounded masses of granite,
upon the summit of several high hills; these evi-
dently owing their origin to the decomposing
breccia.

CHAP.

ARRAN.

CHAP. III.

CORRY, COCK OF ARRAN, AND LOCH-RANZA.

HAVING now given a pretty extended description of the strata and minerals in the neighbourhood of Brodick bay, we shall, in the next place, proceed to trace the strata round to Loch Ranza; which is situated upon the north-west side of the island.

From Brodick bay, the cliffs all round are low, and for a great way composed of the usual red sandstone, which is much traversed by veins of basalt, of various widths, and running in many different directions. Coves occur in several places, but none are of considerable size; frequently calcareous stalactites hang from their roofs. The action of the sea upon the sandstone, has given a singular aspect to the whole shore, owing to the
more

more soft sandstone being washed away, whilst the more compact and hard, which appears to have been formed in figures, is left standing in short ridges, or cristæ. The sandstone, as it rises upwards, forms part of the lower region of Goatfield, in the vicinity of the micaceous shistus, which it, in all probability, covers. About a mile from the Cory, about one hundred feet above the level of the sea, there is a stratum of limestone, about twelve feet thick, running at an angle of about 20° . This is covered with red coloured sandstone; but below, interspersed between the limestone and sandstone, there is a layer of a red shistose clay: This stratum has a singular aspect, owing to its being divided into a number of stratulæ, by means of interposed shistose clay: In this clay we observe regular series of shells, deposited in layers (all appearing of the same species) with their convex sides invariably downwards. The stratum is sometimes straight, but is often waved and twisted. It also frequently contains radiated calcareous crystals, which are of a reddish colour, owing to the admixture of iron. In a fissure of the sandstone, above the limestone, I observed stalactites of peat, of considerable size and consistence

sistence, which appear to have been formed by the infiltration of the soluble peat-matter through the sandstone. Immediately above this stratum, at some distance, is the rugged, steril-looking Cory-glen, which lies upon one side of Goatfield, running nearly east south-east. It is very precipitous on all sides, is broader than any glen in the Goatfield groupe, but is comparatively shorter, and its bottom is higher than that of Glen-Rosa, but not so much elevated as that of the Cory-dain or Feun-hody. It is entirely composed of granite, which is here split, as usual, into immense blocks, that are piled in vast tumuli upon the tops of the surrounding mountains, or cover the sides and bottom of the glen, as with ruin and desolation. But to return: upon leaving the limestone stratum, and going towards the Cory, we observe, upon the sea shore, a vein of soft red shistose sandstone, containing rounded pieces of argill, running through the sandstone, north-east and south-west. At the Cory, where there are a few houses, we observe quarries of sandstone, of a beautiful white colour, and of good consistence for building. These quarries are now worked by a company, for the construction of the Crinan Canal. Here there is also

a stratum of limestone, about thirty feet thick, considerably inclined to the horizon, running north north-west, and south south-east, and divided into stratulæ, as the stratum formerly mentioned, with intervening clay and shells, but the clay is more or less indurated. From this towards west Sanicks, the shore is composed of the common red coloured sandstone, intersected here and there with veins of basalt; but it is often so covered with boulder stones of different kinds, as to render travelling very difficult. The rounded masses of granite, scattered up and down here, are of a most astonishing size; some of them hundreds of tons weight. Near to the Sanicks, there are immense strata of breccia, which is composed of rounded fragments of quartz, and micaceous shistus, cemented by an arenaceous ground. The breccia is in many places much broken. Immense masses of it, many thousand tons weight, lying separated from the strata only a few feet, render it probable, that these masses were disunited by frost. In one place, I observed, a considerable section of the breccia, which I examined very carefully, in order to discover if the masses of quartz, were compressed and smaller at

N

the

the lower than the upper part, but I could not observe any difference. A very remarkable instance of this kind has been observed in other countries; thus in Bergm. Erde-Besch. 182, we are told that in the mountains of Quedilix and Portfiælet in Norway, which consist of an argillaceous puddingstone, the siliceous pebbles it contains, are observed to be compressed to the thickness of the fourth of an inch, in the lower parts of the mountains, but to increase in size and roundness in proportion as their situation is higher. Also in the Vivarois, the lowest strata of primitive limestone, have been found of the thickness of one-tenth of an inch; but in proportion to their elevation in the mountain their thickness increases, until at its summit, it arrives at thirty or forty feet. 1. Soulavie, 178. Ferber made the same observation in England.

At a little distance from the shore, is the entrance into the deep Glen-Sanicks, which is about four miles long, running nearly east and west, bounded on both sides by lofty mountains: on the north, the Cairns, with part of Cairn-na-callich; and towards the south, Keich-na-hein and Coatfield,

Goatfield, form boundaries awfully grand. The sides of the glen are much furrowed by the action of the rain. This circumstance, with the red colour of the decomposing granite, the immense blocks that cover the sides and tops of the mountains, form altogether a sterile and tremendous scene.

—————In lonely regions, here retired
From little scenes of art, great Nature dwells
In awful solitude.

Here we observe several veins of basalt traversing the granite, and in some places we can trace the perpendicular veins; from the bottom to the top of the mountains. At the top of this glen is the hollow called Cory-na-huave, which is bounded by Cairn-na-calligh and Keid-voe. Its bottom is higher than that of Glen-Sanicks, and is all composed of granite, penetrated with veins of basalt, some of which have a considerable degree of curvature. The water from the surrounding mountains is collected in this hollow, and rushes over its elevated bottom into Glen-Sanicks, through which it passes. Before reaching the sea, it forms a considerable stream, named Sanicks-burn, which is filled with boulder-stones, from the neighbouring mountains. After passing

this burn, we find the sandstone, breccia and basaltic veins still continuing, but the appearance of the mountains is much changed; the peaked summits, and almost perpendicular furrowed sides, now disappear; the mountains are clothed with heather to their summits, which are more or less round-backed, intimating an alteration in the materials of which they are composed, which is really the case, as the granite has now disappeared, the summit of the largest hills being of micaceous schistus. We now wander along a mile or two of shore composed of sandstone, when our attention is arrested by the remains of workings for coal, at a little distance from the famous sea-mark, the Cock of Arran. This stratum which is but of small extent, runs in the sandstone accompanied by the usual coal metals, as they are called, and at the bottom of a mountain of micaceous schistus. It is of that kind which is found at Kilkenny in Ireland, and is called in this country Blind Coal.* I observed two pits, about fifteen feet

* Dr Hutton conceives, that this species of coal presents an irrefragable proof of the truth of his theory. Here, says he, is a coal having all the properties of that which has been submitted to the

feet deep, which had been dug in cutting the coal stratum; but as the coal soon disappeared, the pits were left, and the salt pans which had been erected, were rendered useless. The situation of this stratum is such, as to preclude all hopes of finding any considerable quantity of coal, although fresh sections were made; for we invariably find it to be the case, that wherever coal strata come into the vicinity of high mountains, they then most certainly decrease in breadth, and become bad, owing to the great admixture with earthy matter. It is nugatory to say that the strata will be found in the opposite sides of the mountains; this is never the case, nay even in low basaltic hills, we do not find the strata on the opposite side, as they are there only to be observed rising to a considerable height upon the hills, and never in Scotland above eight hundred feet. The great frequency of basaltic veins is another cause, which must

the action of heat; the bitumen is separated, and charcoal remains. To the Neptunists, this affords one of the strongest facts against the theory; the separation of bituminous matter shows a want of immense compression, which is the grand fundamental basis of the hypothesis; it is indeed this circumstance principally which distinguishes it from the Volcanic Theory, and has led Mr Kirwan to name this the *Plutonic*.

must render the coal, if it should ever be detected, of an indifferent quality and difficult to work.

From this stratum to the Cock, which is the most northern point of the island, the shore is covered with immense masses of sandstone and breccia, which have tumbled from the neighbouring hills, by the action of the weather. *Ironstone is found scattered upon the shore, and is probably connected with the coal workings. The Cock is not, as I expected, a great headland, but merely an enormous mass of sandstone, lying loose upon the shore, having a fancied resemblance to the head of the Cock. Here the cliffs are of considerable height, composed of sandstone and breccia, traversed with veins of basalt of various sizes; one of these veins is composed of a curious matter, resembling porphyry, and towards the sides, where it is in contact with the sandstone, it

* Dr Hutton imagines that those ironstones which pass by the name of Septaria, afford distinct marks of having been formed from a state of fusion. All this is founded upon a partial examination of the appearances; it is said that we cannot perceive the spathose matter, entering from without; this however is a very common appearance, of course the Doctor's explanation falls to the ground.

it is hard, and much resembles hornstone. After leaving this, an astonishing appearance presents itself to our view, of the whole face of an immense stratum of breccia, which was torn to pieces, and rolled towards the sea, by the intense frost two years ago; the crash of its fall was heard far off. The sandstone upon this part of the shore has a curious appearance; the strata are alternated with layers of shistose clay, and have the appearance of a regular pavement, being formed into two, four or six-sided irregular figures, connected together by the clay, which being decomposed, leaves the sandstone lying upon the shore in irregular shaped pieces, which have much the appearance of art. From this to within a mile of Loch Ranza, the sandstone, as usual, forms the cliffs upon the shore, and is backed by mountains of micaceous shistus, upon which it rests. Here however the sandstone disappears, and the micaceous shistus now forms the cliffs, which become higher as we approach Ranza. At this place, I expected to find the basalt penetrating the micaceous shistus, as Dr Hutton remarks, and was not disappointed; for, at the place where the sandstone disappears, there is a great basalt vein, about thirty feet wide, running

running in the micaceous schistus, which is here so compact, as to be difficultly distinguished from the basalt. As we approach nearer to Loch Ranza, the sea has exposed several other similar appearances, but far more distinct than the first. These veins are of various sizes, some are curved in their direction, one in particular, is forked, or divided into two branches, which run in very different directions through the micaceous schistus. A few hundred yards from the entrance of the Loch, the sea has formed an interesting section of the strata, which demonstrates, in a satisfactory manner, the relative position of the sandstone, limestone, and micaceous schistus. A large basalt vein, between ten and twelve feet, is to be observed traversing the micaceous schistus, with a slight degree of curvature. At the extremity of the vein, visible at low water, we observe the basalt covered with micaceous schistus. Immediately above this is a stratum of limestone, which contains rounded fragments of a kind of hornblende, and above this is the sandstone, all running at the same angle. Many other veins may be observed traversing the micaceous schistus, before we arrive at the entrance of Loch Ranza, but any detailed accounts of these would be

be but a repetition of what has been already mentioned.

GLEN-RANZA.

This glen is about two miles long, and half a mile broad, running nearly north and south, bounded on both sides by lofty round-backed mountains, that rise at a very considerable angle, and are nearly of the same height on both sides of the glen. The inclination of the opposite mountains is the same, and the strata run at the same angle. The bottom of the glen is but little elevated, being nearly level; about one half is covered with a salt water loch, which adds greatly to the beauty of this romantic spot. The hills are composed of micaceous schistus, containing a greater or less proportion of quartz and mica; indurated chlorite is also dispersed through it, and towards the mouth of the loch there is a considerable stratum of ardesia, or primitive argillaceous schistus. Primitive limestone occurs upon one side of the loch, but I had not an opportunity of examining its situation.

From the top of Glen-Ranza, we enter, by a narrow passage, into a long deep glen, running
O nearly

nearly in the same direction, called Glen-na-birach, bounded, on both sides, with mountains of micaceous schistus, which lie upon the granite. On advancing further up the glen, the micaceous schistus disappears, when both sides are formed of granite, of the same kind as that from Goatfield. The bottom is also formed of granite, as is well demonstrated by the stream, or burn, which has laid bare the rocks through the whole extent of the glen; it is indeed by rivulets of this kind that we are enabled often, to have a distinct view of the mineral structure of highland countries. From the further extremity of this glen, is the ascent to Cairn-na-cailligh, which is in several places rugged and difficult, from the number of loose blocks of granite spread all around. Upon ascending, we first stop at the edge of what is called the Garife-hodie. Here a wonderful and most tremendous scene presents itself to our view. An immense hollow, many hundred feet deep, dreadfully rugged and broken, almost entirely surrounded with mountains, whose serrated summits are covered with immense tumuli of granite, exhibits to us, in very legible characters,

acters, the vast operations of nature, in the formation and decomposition of our globe. What man, possessed of reason, contemplating this awful scene, could doubt of the existence of that BEING, whose power and wisdom are far beyond the reach of human comprehension? If such a man exist, vanity, not soundness of judgment, is the distinguishing feature of his character. Few, indeed, of those who deny, or even doubt the existence of Deity, have ever beheld, far less studied, the stupendous and awful works of nature. It is not, then, much to be wondered at, that the pride and arrogance, which so often characterise the closet philosopher, should find their way to mix with the most daring and impious speculations; speculations, which have for their end the propagation of the worst principles, the dissolving of all the bonds, and destroying the sweetest endearments of human society.

Upon the edge of the hollow, I observed several fragments of porphyry, but I could not discover any fixed rocks of it, owing to the blocks of granite scattered all over the sides of the mountains. In ascending from this, to Cairn-na-

calligh, several other appearances of porphyry, and also fragments of basalt and pitchstone, presented themselves. After considerable fatigue I was so fortunate as to discover two veins of basalt, upon the side of Cairn-na-cailligh, looking into the Garife-hodie; and, between these, there appeared a perpendicular vein of pitchstone, all running in the common granite. This pitchstone, is of a green colour, much resembling that from Brodick wood. It forms a vein, about two feet wide, and, what is remarkable, it is formed into regular columns, from two to twelve inches in diameter, and having from three, to six irregular sides. I could not, however, detect the situation of the porphyry, altho' it was scattered in some places of the mountains in considerable quantities. Having gained the summit of this great mountain, which is nearly of an equal height with Goatfield, we have a very extensive view; and a better opportunity of observing the position of some of the glens, than even from Goatfield itself, particularly that of

GLEN-ERSAY.

This glen which is the largest in the island, is upwards

wards of seven miles long; its sides are lower and less precipitous than the glens about Goatfield, and the hills are round backed, having their summits covered with heather, marking the disappearance of granite, and the presence of micaceous schistus or scenite, but more likely the former, as the scenite does not form such high hills in this island. The top of this mountain has a most singular appearance, owing to its being covered with enormous piles of quadrangular masses of granite, which have the appearance of artificial tumuli: This appearance is by no means peculiar to Cairn-na-calligh, for we have already remarked it upon the top of all the granite mountains in the island; only here the masses are of vast size, and placed upon each other in a most fantastic manner. Here we can trace the granite in its various stages of decomposition, from the solid rock to the loose sand; in its beginning disintegration the granite splits into masses, having a greater or less tendency to the quadrangular form; but these masses have still a degree of connection amongst themselves, as is the case upon the mountain top. The next step is the enlargement of these fissures, by which the masses are loosened from their connection, and tumble down from their elevated

elevated situations, or are hurried with impetuous velocity down the mountain side, covering the bottom of the glens with their stupendous ruins. Lastly, these detached masses, by the action of the weather, are completely disintegrated, forming a loose sand, which is left upon the tops or sides of the mountains, and is carried in great quantities to the sea shore by the torrents *. Saussure, at section

* Dr Hutton remarks, that the stony matter of this globe has been formed by the decay of a former world, whose debris has been collected by various means, at the bottom of a former ocean. This part of the Huttonian theory differs but little from that of Count Buffon: it includes, however, the question concerning the divinity of the world; a speculation, fit only for fanciful metaphysicians. Leaving, therefore, such abstruse and useless quibblings, let us examine matter of fact. Here, however, we are disappointed; not a shadow of proof is brought of the debris being carried to the bottom of the ocean; on the contrary, we observe the decomposing materials of mountains filling up hollows, or forming plains. In the other instances, the debris is carried to the sea shores, (as in the case mentioned above) where it is mixed with the waters of the ocean, and latterly thrown back upon the same or other shores, forming great tracts of land. Thus, the lands of Holland, the delta at the mouth of the Nile, are remarkable examples of this fact. The town of Damietta, in lower Ægypt, about the year 1243, was upon the sea shore, but is now above twelve miles from it; the town of Fooah, which, three hundred years ago, was situated at the mouth of the Nile, is now seven miles distant from it.

tion 604 of his *Voyages dans les Alpes*, remarks, that granite is disposed in strata, but that they are not always to be distinguished, particularly in the granite of low countries and plains. This he conceives to be owing to the granite of low hills, containing a great quantity of *pierre de corne* *. This
 pierre

it. The country about the Baltic is gradually incroaching upon the sea. Linnæus remarks that the sea ports of east and west Bothnia, are every year decreasing, and becoming incapable of admitting vessels; the inhabitants of the ports are obliged to change their seats, and sometimes remove a quarter of a mile nearer the sea. On the eastern side of Goth-land, near Hoburg, the increase of the continent for these last ninety years, is about two or three toises annually. The inhabitants of west Gothland remark that the sea decreases every ten years four or five lines perpendicularly, which, amounts, to forty or fifty lines in a century.

According to this calculation, 600 years ago the sea was 25 inches deeper than it is at present. In Arran we have also a striking proof of the formation of land by the accumulation of debris. Innumerable other instances might be mentioned, but these are sufficient to demonstrate the formation of land, without the supposition of the debris being carried to the fathomless depths of the ocean, and subjected to intense heat.

* It is difficult to say, in this instance, what particular fossil is here alluded to, as Saussure under this name, confounds Basalt, and Hornblende. In one of the late volumes of his travels, he remarks, that wherever *Pierre de Corne* occurs cristallised, it is called Hornblende. All this, however, does not clear up the present difficulty.

pierre de corne, he continues, contains a great proportion of argillaceous earth ; and as most stones, which have this earth, as a constituent part, and in considerable proportion, split into rhomboidal masses, so he concludes that it is the earth of pierre de corne which is the cause of the splitting of granite, forming the numerous masses, which prevent us from observing the strata. This explanation, however ingenious, does not hold true with regard to the granite of this island ; no argillaceous stone of that kind enters into its composition, yet still it splits into rhomboidal masses.

GLEN-HALIMIDEL.

Upon the east side of Glen-Ranza, there is an opening leading to a glen, named Halimidel, which is about two miles long, running W. N. W. and E. S. E. but which soon changes its direction, running nearly in a line with Es-na-birach. It is narrow at the bottom, but widens upwards, owing to the inclination of the sides, which form an angle of about 60° , and the bottom also rises, forming a considerable angle with the sides. It is composed of various species of micaceous schistus, indurated chlorite, ardesia, or argillaceous schistus
and

and quartz. In several places basalt veins may be observed traversing the micaceous schistus, many hundred feet above the level of the sea, even in the bottom of the glen, where the burn has exposed the micaceous schistus, we observe basalt veins crossing it. Upon the east side of the glen, several hundred feet above the level of the sea, there are two quarries, which were formerly worked for ardesia, but are now discontinued. The ardesia is of various colours, generally bluish green, intermixed with white quartz, and the fissures often contain crystals of actynolite, and a species of quartz, penetrated with actynolite, or what may be called *Prase*.

P

C H A P.

ARRAN.

CHAP. IV.

DESCRIPTION OF THE FOSSILS, OCCURRING IN THE PRECEDING CHAPTER.

LIMESTONE CORY.

Colour.—Grey.

Lustre.—A very faint degree of lustre.

Transparency.—None.

Hardness.—Scrapes easily with a knife, emits a strong earthy smell.

Fracture.—Even, fine, splintery, and very compact.

Fusibility.—At 140° Wedgewood, no appearance of fusion.

Another

Another species is also found at the Cory, of a brown colour, minute foliated, difficultly scraped with a knife, and wanting transparency.

LIMESTONE near the Cock.

Colour.—Brick red.

Lustre.—A slight degree of lustre from some dispersed foliæ.

Transparency.—None.

Hardness.—Pretty difficultly scraped with a knife.

Fracture.—Generally foliated, passing to the compact earthy.

INDURATED LITHOMARGA?

Colour.—Pink?

Lustre.—None.

Transparency.—None.

Hardness.—Yields to the knife with considerable difficulty, gives a pink streak.

Fracture.—Even, bordering upon the fine splintery. Does not stain the finger. Feels dry; does not stain the fingers, nor acquire a polish by friction.

friction. After immersion in water for two days, no appearance of disintegration.

BASALT, from a vein near the SANICKS.

Colour.—Greyish green.

Lustre.—None.

Transparency.—None.

Fragments.—Uneven earthy.

Hardness.—Pretty easily scraped with a knife.

Fusibility.—Melted at 58° .

COCK COAL.

Colour.—Black; when fresh broken, sometimes reflects a golden yellow, or violet colour.

Lustre.—Is that of metals not much polished.

Hardness.—Yields rather with difficulty to the knife.

Fracture.—Plain foliated.

Is not coated with whitish effluvia, as that from Kilkenny in Ireland. It does not stain the fingers.

Hardly burns until wholly ignited, when it consumes slowly, with a slight lambent blue flame, which

which continues for a short time. According to Mr Kirwan's method, it contains in the 100 parts, 93 of carbon, and 7 of ashes.

Mr Kirwan, in the second volume of his Mineralogy, remarks, that coals are not soluble in acids. I have observed, however, that they are all rendered completely soluble in water, by means of the nitrous acid, the carbonaceous basis appearing to be converted into an oxyd.

ARDESIA.

ARGILLITE, Mr Kirwan. Primitive argillaceous
Shiftus.

Colour.—Greyish blue, or greyish green, sometimes both colours are intermixed in the same specimen.

Lustre.—Silky.

Transparency.—None.

Fracture.—Streight, flaty.

Fragments.—Tabular.

Hardness.—Yields pretty easily to the knife.

Streak.—Grey.

Does

Does not adhere to the tongue, feels rather greasy, particularly the green coloured; does not stain the fingers. There are often interspersed in the fissures, crystals of glassy actynolite.

CHAPTER

ARRAN.

C H A P. V.

*GLEN-CATACOL, SHISKIN, TORY-LIN, BENIN-HEAD,
WHITING-BAY, LAMLASH-BAY, LAMLASH-ISLAND.*

HAVING surveyed the glens and strata in the neighbourhood of Loch-Ranza, we shall now proceed around the island by Glen-Catacol, which is about a mile and a half from Ranza. The shores are bounded by cliffs, which are not very high, or rugged, but beautifully adorned with low shrubs, giving a richness of appearance, seldom observed upon the barren shores of this island. The cliffs and mountains in the vicinity are formed of micaceous schistus, of various degrees of hardness, owing to its being more or less intermixed with quartz; they are separated from the sea by low beaches, of considerable extent, which, in some places,
are

are cultivated. The entrance to the glens is bounded by lofty, precipitous, mountains of micaceous schistus; but this soon disappears, as the glen changes its direction, running N. N. E. and S. S. W. Then the mountains are formed of granite, similar to that of Goatfield. In several places of the glen, fragments of basalt occur, demonstrating the presence of veins penetrating the granite, as we have already observed, upon Cairn-na-calligh, and Glen-Rofa. At the top of the glen, in a considerable plain, is situated Loch-Tannoch, which is about a mile long, and half a mile broad, elevated several hundred feet above the level of the sea. It is bounded upon two sides, by lofty granite mountains, but is open towards the others, one leading to Glen-Ersay, the other to Catacol. The margin of this lake partakes much of the sterility of the surrounding scenery; vegetation hardly shews its head; a few lichens and tufts of heather are the only ornaments of which it can boast.

————— A joyless coast,
Around a stormy lake, —————

Yet here the grandeur and sublimity of the surrounding granite mountains, enveloped in clouds and mist, excite in our minds a vast variety of ideas; for,
Surely

Surely there is a hidden power that reigns,
 'Mid the lone majesty of untamed nature,
 Controlling sober reason —————

Upon ascending the granite mountains on the east side of the loch, I observed considerable quantities of the debris of basalt veins upon the top of the mountains, showing that they had penetrated the granite hills to the very summit. In descending from these mountains, we enter into a glen of some extent, running in an opposite direction from Catacol, but falling into it near its entrance. Upon the sides of this glen, which are of granite, great masses of porphyry were scattered, but I could not detect any in situ ; it is probable, however, that it forms veins running through the granite, as the quantity of debris is too small for supposing the existence of strata *.

Q

From

* Dr Hutton remarks, that " Granite is a compound, which
 " graduates into porphyry ; but porphyry is only a whinstone, of
 " a harder species. Therefore, though perfectly distinct, these
 " three things graduate into each other, and may be considered as
 " the same." This rapid conclusion cannot be admitted : basalt,
 it is well known, has usually a uniform appearance with a splintery
 or conchoid fracture, it sometimes contains crystals of felspar, and
 hornblende, forming a species of porphyry, which is not harder than
 basalt.

From Catacol to Whitefarland, a farm belonging to Fullerton of Kilmichael, the cliffs are low, composed of micaceous shistus, but defended from the action of the sea, by intervening sea banks, similar to those noticed between Catacol and Loch-Ranza. Near to the farm of North Tundergay, I observed a remarkable vein of basalt, penetrating the micaceous shistus. The micaceous shistus is much waved, but as it approaches the side of the vein, it loses its shining glimmery appearance, becomes more solid and compact, breaks into thick plates, and where in immediate contact with the basalt, it is difficultly distinguishable from it. The vein, as it rises from the sea, is fairly crossed by a species of micaceous

basalt; indeed we frequently observe the same mass, in part porphyry, and part basalt. That granite graduates to basaltic porphyry, no one has ever demonstrated, and we must believe that such an appearance is ideal, founded upon false reasoning. We might as well say, according to the Huttonian language, that granite graduates into serpentine, because we observe serpentine porphyry, or into hornstone, because we observe hornstone porphyry, or into pitchstone, because we observe pitchstone porphyry. It may be answered to this, that Dr Beddoes has determined the gradation of basalt into granite; to me, however, this has as little probability as the other, for as far as I have examined, no such gradation is to be observed near Edinburgh, where Dr Beddoes says he noticed it.

micaceous shistus, approaching to breccia; and here also the basalt and micaceous shistus are much jumbled together, and some pieces of the vein are distinctly insulated in the micaceous shistus. Here then we have two facts, the former the apparent transition from basalt to micaceous shistus, or micaceous shistus to basalt; the other, masses of the basalt immersed in the micaceous shistus, in a similar manner to the basalt we observed embedded in the granite, upon the side of Glen-Rosa. At Whitefarland, there is a considerable extent of natural wood, which adds greatly to the beauty of its appearance, which is much heightened by the lofty mountains that bound it on one hand, with the sea and long extended isthmus of Cantyre on the other. From this to Imachar, the same micaceous strata continue, forming beautiful cliffs and considerable sea beaches. At Imachar, the micaceous shistus is much twisted and traversed with quartz, so as to give the whole a kind of maculated aspect; and it continues to form cliffs, until we come to the stream which runs down from Glen-Irfa. Here the micaceous shistus, indurated chlorite, argillite, and other alpine rocks disappear; when crossing the stream, the sandstone presents itself to

our view. A very considerable sea beach, covered in part with grass, is interposed between the sandstone and the sea; and the strata of sandstone, from the situation in which I viewed it, appears to be more elevated than any I had observed in the other parts of the island, and the retreat of the sea is strongly marked by the caves which are dispersed in these cliffs. These cliffs, however, continue but for a short way; for, upon arriving at Machry-Bay, we find it bounded by the low shores, and the plain of what is called the town of the Shiskin. At the Shiskin, the land is low and flat; the mountains in the neighbourhood have a different appearance from those about Loch-Ranza; are lower; their sides less precipitous; in short, have much of the general aspect of those about Glen-Cloy, all announcing a change in their composition, which, upon examination, we find to be the case. The Clachan glen, which is but a short distance from the Shiskin, is composed, as far as I examined, of sandstone and breccia of the common kinds. Upon the summit of the south side, I observed a considerable stratum of lime-stone, which is covered, and even intermixed in some places, with sandstone and breccia. As the glen winds upwards, the hills,

hills become higher, being in all probability composed of scenite, penetrated with veins of basalt, and porphyry, for we find the bed of the burn covered with boulder stones of basalt, porphyry and scenite.

About two miles north west from the Shiskin, after passing through a moorish flat, we come to Drumoodon, which is the promontory of this plain. Here there are cliffs of considerable extent, which contain a range of extensive caves, celebrated by tradition, as the resting place of Fingal, the father of our Great Ossian, who, it is said, used to retire here after the fatigues of the chase. In the further extremity of the greatest, or what is called the *King's Cove*, are a few scratches, made by idle fishermen, or smugglers, which, by some, have been referred to the Fingalian age.

As the appearances at this promontory are very interesting, I shall begin the description from the north east end, or Machry-bay, and so on to Car-barn point, or the Basaltic promontory. The bay is of considerable extent, and the shore all around to Irfa water, is formed of sandstone; the bottom
of

of the bay is a low sandy beach, but towards the promontory of Drumodoon it rises, forming cliffs, which are continued all around to the Garbarn point, for the space of about a mile and a half; and these cliffs are from forty to one hundred feet high*. The first object which strikes the eye of the mineralogist is the great vein of pitchstone, which is to be observed rising from the sea, and running east north-east, and west north-west, until it nearly reaches Machry-Bay. It is about ten feet wide as it rises from the sea, is of a green colour, like that upon the Lamash road, and runs in the common red sandstone. Upon one side of the vein we can trace the gradual change of appearance in the pitchstone as it approaches the stratified matter, forming a substance intermediate (if I may be allowed the expression) between pitchstone and sandstone; and in other parts veins of basalt are to be observed running between the pitchstone and sandstone.

In
* Between the cliffs and the sea, upon the beach, there are several remarkable appearances of basaltic and other veins, which render this spot the more interesting.

In tracing this vein, we observe it running for a considerable way without any interruption; at length a vein of basalt, six or seven feet wide crosses it, and rises into the opposite sandstone cliffs; unluckily the meeting of the two veins is so covered with loose stones, as to prevent any examination of their appearance. It is certain, however, that the pitchstone is not changed in its direction, for it soon makes its appearance again from under the debris, when it can be traced for some distance uninterrupted by basalt veins; at length it is crossed by a great vein about twenty feet wide, which is seen traversing the neighbouring sandstone cliffs. But this is not the most singular part of the appearance; here also the pitchstone appears to send off a great branch, which rises into the neighbouring cliffs, but its appearance is different from that of the great vein; it is in general more hard, its colours are various, and it approaches more or less to the nature of hornstone. The further course of the pitchstone cannot be at all discovered for a considerable way, as it is quite covered with debris, which is scattered upon the shore; but we observe six or seven basalt veins running across its direction, which can be traced
into

into the neighbouring sandstone strata for a considerable way. The pitchstone now makes its last appearance, running still in its original direction, but more diversified in colour, hardness, &c. having much resemblance to the great branch we before observed. A very considerable vein of green pitchstone is now observed, rising from the sea, running in a cross direction to that of the other vein; but their intersection or meeting is hid by the debris, which now prevents all further examination of their course or direction.

The next object which claims our notice, is the relative position of the sandstone and porphyry, a circumstance which before engaged our attention in the description of Glen-Cloy, and Cory-Gills. The cliffs beside the sandstone, which forms their greater part, are in some places skirted by a porphyry, very similar to that of Glen-Cloy, with the parts a little more distinct, and here and there penetrated with veins of basalt. One vein, which is about six or seven feet wide, runs in the porphyry in a perpendicular direction, gradually narrowing towards the top of the cliffs, when it is lost among the sandstone, which lies immediately behind the porphyry.

porphyry. Another vein is to be observed running in a different direction through the porphyry : as it enters the cliffs, it runs between the sandstone and porphyry. These two veins can be traced in their course through the sandstone, for a considerable way in the level plain of the Shiskin, each running in an opposite direction. Another vein, which is nearer to Machry-Bay than the other two, is to be observed running with porphyry on one side, and sandstone on the other : it soon divides, one branch penetrating the porphyry, the other running between the sandstone and porphyry. On the west of the King's-Cove, near the top of the cliffs, there is a considerable vein of pitchstone, which traverses the sandstone strata, but it is so hid as to prevent any accurate knowledge of its size or direction. It differs, however, very much, in external appearance, from the other veins, not only in colour, but also in lustre and hardness. At a little distance a stratum of porphyry, whose felspar is decomposed to an ochraceous substance, rests upon the sandstone, having a tendency to the columnar form. This continues until we arrive at the columnar promontory of Carbarn, near the farm of Drumodoon. On the

R

way

way to this promontory, several veins of basalt, some of them of considerable extent are observed traversing the sandstone. Upon examining the connection of the veins and the strata, I was surprised to find the basalt and sandstone at their junction in several places intermixed with each other; and, what is curious, the veins of basalt, besides the angle they form with the horizon, have a considerable inclination of themselves.

Having arrived at the promontory of Carbarn, we find it to be composed of a species of porphyry, forming columns not very regular, and standing upon red coloured sandstone, the whole being nearly of the same height with the cliffs. The porphyry, in some specimens, has exactly the appearance of basalt porphyry, but in others it cannot be distinguished from the wacken porphyry we have so often mentioned; and we also find that the wacken porphyry, where it is penetrated by basaltic veins, has often the appearance of this species.

From these facts, it appears that the porphyry generally rests upon the sandstone: they also
show

show a gradation or connection between basalt, wacken and pitchstone.

Having passed this promontory, we come to the farm of Drumodoon, which is situated upon the sea shore, with a considerable sandy beach before it; behind, the sandstone-cliffs are still continued, but are now considerably lower, and soon disappear altogether, being succeeded by an extensive beach covered with fragments of the neighbouring rocks. Here we find, resting upon the sandstone, a curious species of rock, intermediate between sandstone and basalt, and having a tendency to the basaltic form. After passing this beach, which forms one side of the plain of the Shiskin, considerable cliffs now rise before us, which are formed of wacken-porphry of considerable height, but much split by the action of the weather, which gives an indistinct idea of stratification, similar to the granite observed in the Cory-Dain, at the head of Glen-Rosa. These cliffs contain several caves, but none of them are of any considerable size, and the shore is covered with great masses, which have been separated from

the cliffs by the action of the sea and weather. These masses have a peculiarity of form, which characterizes the rock from which they have been separated. This remark may appear fanciful, but several circumstances lead me to imagine, that one accustomed to observe with attention the debris upon the sea coasts, &c. may without hesitation, guess as to the peculiar nature of the rocks themselves, without a close examination. The whole shore to Tory-lin, appears to be composed of porphyry, with sandstone here and there, and both penetrated with veins of basalt, and dark green coloured pitchstone. The hills back from the shore are formed of scenite, which is very probably penetrated with veins of basalt, as that at the head of Glen-Cloy. From the Shiskin to Tory-lin, there is a tolerable road, which is a rarity in this island, and extremely agreeable to the traveller, after having scrambled around the shore from Brodick bay. The land now becomes lower, and has more of the rural appearance of the lowlands of Scotland. Agriculture is followed with some spirit, and even many of the sea beaches are cultivated.

Tory

Tory-Lin consists of a few houses, pleasantly situated in a hollow, at a little distance from the sea shore, and surrounded with sandstone hills. In the burn which runs past the houses, I observed veins of basalt penetrating the sandstone in different directions, and amongst the boulder stones which cover its bottom, fragments of an olive green coloured pitchstone presented themselves, showing the existence of veins of that fossil in the neighbourhood. Upon the shore a curious species of porphyry, (different from wacken-porphry,) makes its appearance, and seems to be traversed with veins of common basalt, which are here of very great size. The shore from this to the Benin-Head, the most southern part of the island, is principally composed of sandstone, penetrated with veins of basalt, which are sometimes of great size, and run in a great variety of directions. The hills back from the shore appear to be entirely composed of scenite and porphyry, but are not of any great height, and the whole country to the Benin-head is considerably cultivated, and here and there interspersed with small villages, and flocks of cattle, which give to the whole a picturesque feature, which we have seldom an opportunity

portunity of observing in this island. At the Benin-head, the cliffs are of considerable height and very precipitous. It is composed of a curious species of basalt and porphyry: the basalt is traversed by perpendicular veins of a basaltic rock of a different species, and has a tendency to the columnar form, which is also the case with the porphyry.

From this to Whiting Bay, the cliffs are low, formed of sandstone penetrated with basalt veins, which run in a vast variety of singular directions. The hills however, up from the shore, now change their appearance, presenting broad, bare, perpendicular faces, similar to those which occur in all basaltic countries; and upon examination, we find them to be composed of various species of basalt,* lying upon a red coloured sandstone, which is intermixed with grunerde, and a grey
schiefer

* An important observation has been lately made upon the Continent, by Suckow, a considerable mineralogist. Upon breaking a species of basalt which contained several cavities, he found them filled with a transparent colourless water, of which he collected two ounces, and found that one hundred grains held in solution two grains of siliceous earth.

schiefer thon. This basalt is often columnar, and the perpendicular crags being scattered in various directions, and often rising in groupes above each other, have a pleasing effect.* Near to Whiting bay, there are considerable rocks of *grunstein*, of nearly the same kind with that found near the Cory-gills; it is not in any considerable quantity, and appears to be the most unfrequent rock in the island.

At Whiting bay, the cliffs disappear, until we come to the entrance of Lamlash bay; in their place we have an extensive beach, bounded by gradually rising sandstone hills, much penetrated with basaltic veins. When the tide ebbs, the bottom of the bay presents a most astonishing and surprising collection of basaltic veins, which have been laid bare by the action of the sea; here they are to be seen running in all directions, meeting and crossing each other in a most curious manner; in

* The columns, although regularly six-sided, are with great difficulty distinguished from sandstone; indeed the greater part of the stratified basaltic matter in this island, appears either to be penetrated with a sandstone, as the columns at Dunbar, or the sandstone is intermediate between basalt and sandstone.

in short, this is one of the most interesting parts of the island, for observing the various turnings, &c. of these singular appearances. At the entrance of the famous bay of Lamlaish, the sandstone forms considerable cliffs, which continue of some height, but are gradually lower as we approach the village of Lamlaish, where there is an extensive flat beach. These cliffs are also traversed with veins of basalt, and in some places a few hundred yards from the shore, I observed many detached masses of green pitchstone, showing its existence in the neighbourhood.

Lamlaish bay, which is the best harbour in the island, and one of the best in the Firth of Clyde, is of a semi-circular shape, and is formed in part by Holy island or the island of Lamlaish, which lies across it, leaving two entrances, one from the north, the other from the south, which last is always preferred by mariners. It is bounded upon the Arran side by hills, which in general rise gradually from the sea shore, the lower part being of sandstone, and the higher, as far as I examined, of scenite. Upon the east side of the bay, attempts have been made to ascertain the presence of coal, but without effect.

Lamlaish

Lamlash or Holy island, is about three miles long, and half a mile broad, precipitous on the east, also considerably abrupt on the west side, but the north and south ends are low. It is composed of red-coloured sandstone, which is in some places formed into small caves; one is celebrated for being the residence of the holy disciple of St. Columba, St. Mool-jos, or the servant of Jesus. This sandstone is covered in many places with a species of basalt, much resembling that near Whiting bay, and difficultly distinguishable from sandstone. It forms in many places regular columns, generally six-sided, which rise range above range, giving a faint idea of the stupendous scenery of Staffa or Bo-shela. Upon the west side, the columns are of greater size than upon the east, and the same matter appears to form the summit of the island, which is reckoned about seven hundred feet high. Towards the south end, several veins of common basalt make their appearance running in the sandstone; and, in several places, a curious species of yellow pitchstone runs through the sandstone in the form of veins.

ARRAN.

CHAP. VI.

DESCRIPTION OF THE FOSSILS, OCCURRING IN THE PRECEDING CHAPTER.

PITCHSTONE, from Drumodoon.

SEVERAL species of this interesting genus, are to be observed at Drumodoon. Of these, the following are the most remarkable.

1st Species.

Colour.—Black, with a brownish hue, intermixed.

Lustre.—As bright as that of silk, but greasy.

Transparency.—None.

Fracture.—Uneven, approaching the splintery.

Hardness.—Gives a few sparks with steel.

Quartz,

Quartz, and a reddish matter, like garnet, is dispersed through it.

2d Species.

Colour.—Yellowish green, maculated with red, and interspersed with black spots.

Lustre.—None.

Transparency.—None.

Fracture.—Uneven, splintery.

Hardness.—Gives a few sparks with steel.

Rounded masses of brown coloured quartz, are dispersed through it. It decomposes in the form of a white tegmen or crust.

3d Species.

Colour.—Yellow, or greenish yellow.

Lustre.—None.

Transparency.—None.

Fracture.—Even, sometimes splintery.

Hardness.—Gives a few sparks with steel.

Fusibility.—A fragment from a six-sided column, much resembling this, softened at 81° ; at 118° a compact brown vitreous mass was formed, which had interspersed white grains.

By decomposition, it acquires a brick red tег-
men.

4th Species.

Colour.—Brown, with shades of black.

Lustre.—Very faint.

Transparency.—Transmits light at the edges.

Fracture.—Even, with a tendency to the splin-
tery.

Hardness.—Gives fire, pretty plentifully, with
steel.

It has a number of white spots dispersed
through it, which acquire a brown colour, by
decomposition, as also the base.

5th Species.

Colour.—Brownish, or greyish black.

Lustre.—Faint.—

Transparency.—Transmits light at the edges,
but more so than the former species.

Fracture.—More or less fine, splintery.

Hardness.—Gives fire with steel, more plenti-
fully than the former species.

Quartz,

Quartz is dispersed through it, in the same manner as in the former, and a few specks of felspar now and then occur. It decomposes in the form of a white crust, or tegmen.

These different species of pitchstone are all to be observed in the same vein, and appear to graduate, or pass into each other, imperceptibly. In the first place, the green coloured, which is the most common, passes to the maculated, or 2d species, and this again into the yellow. In this state it appears to be intermediate between pitchstone and hornstone, for Klaproth found a substance of this kind fusible; and, Mr Kirwan mentions a greenish white hornstone, from Lorraine, which appears to be similar to this, and which he found to be fusible. The yellow coloured species passes to the brown, or 4th species, which has much the appearance of hornstone.

Interposed between the sandstone and pitchstone, we observe a substance, which presents the following characters:—

Colour.—Greyish white.

Lustre.

Lustre.—A faint glimmering, from diffused shining particles.

Transparency. None.

Fracture.—Even, earthy, with a tendency to the splintery.

Hardness.—Gives fire, moderately, with steel.

This fossil appears to be intermediate between hornstone, and sandstone; so that we have now traced the pitchstone, through its different intermediate stages, to hornstone, and this last, appears to be a link of the gradation to the sandstone.

PORPHYRY, with a basis intermediate between wacken and hornstone, but with a greater tendency to wacken.

BASIS.

Colour.—Greyish.

Lustre.—None.

Transparency.—A little at the edges.

Fracture.—Even, passing to the fine splintery.

Hardness.—Gives a few sparks with steel.

It

It contains, immersed in the basis, crystals of common red felspar; and white felspar, approaching adularia; the crystals are of considerable size, and this is one of the principal distinctions between this species and some of those found in Glen-Cloy. It decomposes, in the form of a brick-red crust, similar to some of the pitchstones.

In other specimens, the porphyry, as it comes in contact with the veins of basalt, has a base considerably resembling it; and at the columnar promontory of Drumodoon, the specimens often cannot be distinguished from what is called Trap Porphyry.

A substance intermediate between sandstone and wacken, having a tendency to the columnar form.
Farm of Drumodoon.

Colour.—Yellowish.

Lustre.—None.

Transparency.—None. It feels much like a sandstone.

Fracture.—Even, earthy, with the appearance of rounded concretions.

Hardness.

Hardness.—Gives a few sparks with steel, but it contains confused fragments of quartz, which may have been the cause of this. Emits a strong earthy smell, when breathed upon*.

Fusibility.—Melted at 79° .

* Lampadux has discovered that hornblende contains charcoal diffused through it, and Mr Kirwan suspects that some species of pitchstone contain it. It is conjectured that it may exist in other fossils, and cause the peculiar earthy smell, which we perceive by breathing upon stones.

APPENDIX

APPENDIX,

CONTAINING OBSERVATIONS UPON

PEAT, KELP, AND COAL.

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THE following observations and experiments upon Peat, Kelp and Coal, may appear to some unconnected with the present work ; they are so far connected, however, that these substances occur in the islands we have just been describing, and are there objects of great importance. On that account it has appeared not unuseful to relate the few experiments and observations which I have had an opportunity of making. They are to be considered, however, only as the beginning of an investigation, which I hope soon to prosecute in a more extensive manner.

P E A T.

THIS curious and useful substance has been long known as an article of fuel to the inhabitants of the North of Europe, and used as such in those regions where no coal has been found to defend the inhabitants from the rigors of a frozen climate. The learned Torfœus informs us, that its use was first made known to the inhabitants of the Orkney and Shetland islands, by one Einar, a Norwegian, who, from that circumstance, was named Torf Einar. It soon after this came into very general use, and is now the only fuel of many parts, not only of the islands and Highlands of Scotland, but of other nations in the North.

In describing the general appearance of a peat moor, we may conceive an almost entire flat of several miles extent, of a brown colour, here and

there marked with tufts of heather, which have taken root, owing to the more complete decomposition of the surface peat; no tree or shrub is to be seen; not a spot of grass to relieve the eye, in wandering over this dreary scene. A nearer examination discovers a wet spongy surface, passable only in the driest seasons, or when all nature is locked in frost. The surface is frequently covered with a slimy black-coloured substance, which is the peat earth, so mixed with water, as to render the moss only passable by leaping from one tuft of heather to another. Sometimes, however, the surface of peat mosses have a different aspect, owing to the greater abundance of heath and other vegetables, as the *schoeni*, *scirpi*, *eriophora*, &c. but this is principally the case with some kinds of what are called Muirlands, which contain but little peat, being nearly composed of the interwoven fibres of the roots of living vegetables.

Many different species of peat might be described, but such an investigation is not suited to my present purpose; I shall therefore content myself with mentioning the substance in a general way. Quick moss (as it is called) is a substance of a more
or

or less brown colour, forms a kneadable compound, and when good, cuts freely and clean with the spade; but when it resists the spade, by a degree of elasticity, it is found to be less compact when dried, and is of an inferior quality. The best kinds burn with a clear bright flame, leaving light coloured ashes; but the more indifferent kinds, in burning, often emit a disagreeable smell, and leave a heavy red-coloured kind of ashes. In digging the peat we observe that, when first taken from the pit, it almost immediately changes its colour, and in time becomes more or less of a deep brown or black colour; and the peat matter becomes much altered, being incapable of forming a kneadable paste with water. When dry and reduced to powder, as it is often by the action of the weather, it forms a blackish-coloured powdery matter, capable of supporting vegetation, when calcareous earth is added. Peat earth is very retentive of moisture, which circumstance affords us a satisfactory explanation of the floating islands, observed in many places of Holland, as Frise, Breme, Groningue, Oldenburg, &c. These are caused by the peat earth or turf, retaining so great a proportion of water as to float immense masses of it, which are
driven

driven about upon the surface of lakes, or are floated upon the land itself. This is so well known in Holland, that tracts of moss, of great extent, are secured by means of chains, &c.

Peat is found in very various situations, often in vallies or plains, where it forms very extensive deep beds, from three to forty feet deep, as those in Aberdeenshire; it also occurs upon the sides of mountains, but even there it is generally in a horizontal situation. The tops of mountains, upwards of two thousand feet high, in the Highlands of Scotland, are covered with peat of an excellent kind. In Germany, it is also found at very great heights, thus the Blogsborg, a high mountain in Lower Saxony, and the Brohen, the highest mountain of the Hartz, are covered to their summit with peat. It is also found in situations nearly upon a level with the sea; thus the great moss of Cree in Galloway, lies close upon the sea, on a bed of clay, little higher than flood-mark at spring tides; Locker-moss, hard by Dumfries, about ten miles in length, is only a few feet above high water mark; in
the

the island of Lewis, one of the Hebrides, there is an extensive plain, about thirty miles long, covered with peat moss, having its surface very little elevated above that of the sea. In other places, as in Holland, a kind of peat is obtained by dragging mud from the bottom of canals, and moulding it into the form of bricks; this species is also often taken up upon the flukes of anchors, on the coast of Holland, and is sometimes cast ashore in stormy weather, which has led some speculators to imagine that it is of marine origin. In the harbour of Oban in Argyleshire, one part of the bottom appears to be formed of quick moss, which affords no sure anchorage. The depth of the sea is there about twenty fathoms*.

It appears to be peculiar to cold climates, which is one of the innumerable instances of the wisdom of nature in providing the inhabitants of a cold country, with a material so necessary for their comfort, and even their existence. Dr Anderson, in his Treatise upon Peat, remarks, that it is not confined to cold climates, as he
had

* Anderson's Treatise upon Peat Moss.

had specimens of real peat sent him from the island of Sumatra. It is not improbable that a substance resembling peat in some of its properties, may be found in the warmest countries, when we reflect that decayed vegetable matters, in a certain stage of their decomposition, have an appearance so like peat, that they want only compression to form a similar substance. On this account, it is not surprising, that something of this kind should occur in the warmer regions; but it is impossible to conceive the existence of great masses of matter like our peat, in the Tropical regions. This observation is rendered more probable from the following remarks: In Scotland, it is observed, that the peat, at the bottom of a mountain, is more decomposed than at its top, and the wood of mosses is more fresh upon the higher part of a mountain than at its lower. It is also remarked, that the peat of the South of England is more decomposed than that of the North of Scotland; and the peat of France has more of the coaly appearance, than that of England. In France also, Mr Arthur Young remarks, * that the peat is never found in the low lands, but under

* Travels through France.

under cover of vast size ; and it is only in the higher regions, where the climate is more temperate, that it is to be observed upon the surface. All these facts show us, in a satisfactory manner, that as we advance towards the warmer climate, the vegetable matter is more and more decomposed, until we arrive at the Tropical regions, where, in all animal and vegetable matters, putrefaction proceeds so rapidly, as to prevent the formation of any body of this substance.

It will not be foreign to my present purpose, to mention, in a cursory manner, the most remarkable undecomposed vegetable matters, which have been observed in our peat mosses, or bogs ; particularly as writers have endeavoured to draw conclusions, with regard to the time and mode of formation of peat, from the appearances which these bodies present.

I. FIR or PINE.—This tree more frequently occurs, than any other ; it is found of various sizes, some having been dug about one hundred feet long, perfectly strait, with branches growing in a circular form ; as is the case with the pine

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tribe.

tribe. It is remarkable, that in such situations the wood has often lost its latitudinal adhesion, which renders it soft; but that the longitudinal fibres are strong, and tough, so that they are split, and twisted, to form halters for cattle, as in Aberdeenshire.

2. OAK.—In all the low moor, in Scotland, this tree is the principal one which is to be observed, and is generally found wanting the bark, which shews that the wood had been long dead before it had been enveloped in the moss. In draining Hartfell level, in Yorkshire, oak trees were found, not less than 100 feet long. They were black as ebony, in excellent preservation, and some of them sold, in the middle of the last century, for 15l. a tree. One of them, which is particularly described, was about one hundred and twenty feet long, twelve in diameter, at one end, and six at the other; and 20l. was offered for it. Dr Anderson remarks, that he never saw a piece of oak taken from a peat moss, which could be used in workmanship, like the stakes which were lately taken from the Thames, and said to have been placed there by Julius Cæsar;

Cæsar; from this he concludes that moss does not preserve wood, so long as water. This, however, is contradicted from the facts observed at Hartfell level.

3, BIRCH.—This tree also frequently occurs in our peat mosses, but its wood is not so resinous as that of the fir, nor has it the hardness of the oak; on these accounts it is seldom found in a state of good preservation; the bark is generally the most entire, which may depend upon the great quantity of resin which it contains, which enables it to resist the all powerful hand of time.

The alder, yew, willow, ash, and several other trees, have been dug out of our mosses, but any detailed account of these would lead me to a great deal of unnecessary description: I may here mention, however, that, besides trunks and branches of trees, we also sometimes discover their more delicate parts in a state of preservation; thus the leaves have been observed well preserved. Seeds, which have a remarkable power in resisting the influence of the weather, have been found in peat mosses; thus we have instan-

ces of fir cones and hazel nuts; the kernel of this last was destroyed, and the shell, which is very indestructible, was fresh.

Besides trees and herbaceous plants, another tribe deserve to be particularly noticed, which are the musci. These plants are fond of moisture, and, with a sufficiency of room to spread upon, and a cold climate, grow very fast and luxuriantly. Of these the most remarkable is the sphagnum palustre of Linnæus, which is found in great abundance in all peat districts, particularly in those places where the soft white peat abounds; this peat is found several feet deep, and is nothing but a collection of the sphagnum, which we can observe more or less decomposed as we go downwards; at last its texture disappears, its colour changes, and it cannot be distinguished from the common brown peat.

A curious substance has been found in the peat mosses of this country, which requires a particular description.

Colour

Colour, white; has nearly the resemblance of tallow, feels greasy, and stains paper as tallow does; flames with much smoke, leaving a pretty light coaly matter. It is brittle like tallow, but its specific gravity is considerably less.

A substance similar to this was found some years ago by peasants on the coast of Finland, and afterwards in one of the Swedish Lakes, and lately at Strasburgh. It appears to be the substance described by Mr Kirwan, under the name of Mineral Tallow.—Humbold, in a letter to Van Mons in the *Annales deChymie*, vol XXII. p. 64. mentions, that he had converted the *Phallus esculentus* into a substance resembling tallow, by means of the sulphureous acid, and had also made soap of it. I endeavoured to repeat this with the *Agaricus horizontalis*, by means of the nitrous acid, but without success. May not the mineral tallow of peat mosses be a species of fungus, altered by some natural operation similar to what we have here mentioned?

A great number of extraneous substances have also been found in peat mosses, sometimes at considerable depths, from their appearance, declaring, in certain characters, the great antiquity of such mosses. Many curious instances of this kind might be mentioned; one in particular deserves to be noticed. In digging a moss at Axholm, in Lincolnshire, the body of a woman was found pretty fresh, her hair was unaltered, her nails were rounded, and her skin was tanned, soft and pliable; she had antique sandals upon her feet, which renders it probable that she was of the Roman æra. Another curious instance occurred in Shetland; in digging a peat moss, the body of a man was found well preserved, which, it was supposed, could not have been in the moss, less than eighty years. In the Irish mosses the horns of the moose deer have been found; in our own, the head and horns of the urus occur. Dr Walker has in his possession a drawing of the head and horns of a deer, found in a peat moss, of a species now no longer found in Britain. Other substances occur in mosses; thus, fragments of very ancient dresses, and many instruments of human industry have, at different times, been discovered,

ANALYSIS

ANALYSIS

OF THE PEAT OF GLEN-CLOY.

ISLAND OF ARRAN.

Character.—Is of a blackish brown colour, pretty much intermixed with undecomposed vegetable matter, which renders it rather loose in its texture.

SOLUTION IN WATER *.

1. I took one thousand grains of powdered peat, boiled repeatedly with distilled water, until no more

* Lord Dundonald remarks † that “the sulphuric acid, when concentrated, acts in a similar manner to that of alkaline substances, in the resolution or destruction of animal and vegetable substances, disengaging from them certain gasses, and forming therewith certain saponaceous and saline compounds. These solutions or extracts are of a reddish brown colour, similar to that produced by the action of alkaline salts on oxygenated peat. On the principles already stated, the vitriolic acid may be used beneficially to decompose, and bring into action the insoluble matter accumulated in soils

† A Treatise of the connection of Agriculture with Chemistry, 4to. by the Earl of Dundonald,

more could be dissolved, then dried, weighed, and found eight hundred grains remaining.

The

soils, by the combination of the phosphoric and foreline acids, with calcareous matter." The action of the sulphuric acid upon vegetable substances engaged my attention three years ago, and in a paper read to the Royal Medical Society of Edinburgh, I endeavoured to shew (what has been since done more satisfactorily by Vauquelin and Fourcroy) that acetous acid is formed; that a portion of carbonaceous matter, deprived of hydrogen, remains in solution, and that carbon is separated. It is certain that alkalies exert no such influence upon vegetable substances; in the present instance, they only dissolve a portion of brown dehydrogenated matter, without causing any alteration in the proportion of the constituent parts. Their action upon animal substances, however, is more nearly allied: Vauquelin found, that ammonia was formed by the action of this acid; and I have reason for suspecting that a similar change is produced by the agency of potash or soda upon the muscular fibre. A series of experiments, which my father was lately engaged in, at the desire of the Honourable board of Trustees, led me to make this observation. We found that the muscular fibre of fish, formed a brown-coloured solution, by treating it with the caustic potash or soda: during the solution, a small quantity of ammonia was formed, but in far greater proportion, when tallow is added and the boiling continued. During this extrication of ammonia, a blackish-coloured matter falls to the bottom, which is not acted upon by alkalies; in short, it appears to be the carbonaceous matter of the muscular fibre. This change appears to be a nearly complete decomposition of the muscular fibre, its hydrogen and azote forming the ammonia, whilst the carbonaceous matter is left behind, forming the insoluble matter.

The solution had a deep brown colour, with a slightly bitter taste; tinged litmus paper red; and, by exposure to the air for some time, part was precipitated in an insoluble state.

2. By passing the oxygenated muriatic acid thro' this solution, a precipitation of a dark brownish matter immediately takes place, similar to what we observe by passing this acid thro' other vegetable infusions.

3. Caustic ammonia, or carbonat of potash, did not cause any precipitation in the space of twelve hours.

4. Prussian alkali did not afford any traces of the combinations of iron, copper, or zinc.

5. Lime water formed a copious brown-coloured precipitate.

6. Muriat of barytes, nitrat of silver, sulphat of iron, sulphat of copper, caused considerable precipitations, but nitrat of ammonia, muriat of

X

foda,

soda, muriat of ammonia, did not produce any change.

The solution being evaporated, left a blackish brown-coloured residuum, which had no peculiar smell; nor, had it any appearance of an oil, as Dr Hutton conceives it to be *. It presents the following characters.—

- a. Not soluble in spirit of wine, except by a boiling heat.
- b. Difficultly soluble in water, without the assistance of heat.
- c. Soluble in caustic soda, at the common temperature, or when heated.
- d. Soluble in caustic ammonia in the same manner.

7. A quantity of the residue being put into a retort, connected with a pneumatic apparatus, a gradually increasing heat was applied, when the following appearances were observed. At first water passed over quite colourless; after some time it was tinged brown, and towards the end of the operation, when no more brown liquor

* Hutton's Theory of the Earth, Vol. I. page 578—9.

quor came over, carbonic acid, and carbonated hydrogen passed in considerable quantity: no oil or saline matter could be detected, and not the least traces of ammonia could be perceived. The carbonaceous residue was of a blackish brown colour, insoluble either in hot or cold water, but easily soluble in a weak solution of caustic soda.

The ease with which this carbonaceous matter is dissolved in weak solutions of alkali, shows that it contains a considerable portion of hydrogen, (at least this is the explanation given by modern chemistry); for I find it impossible to dissolve any perceptible quantity of charcoal with such solutions.

8. The residue, by burning, affords a grey coloured ash; which I examined, in order to ascertain the nature of the saline matters. It did not afford sulphur of potash or soda, phosphat of lime, or phosphat of iron; only *sulphat of magnesia, and oxyd of iron.*

To the eight hundred grains, which I found in-

X 2

soluble

soluble in water, I added a solution of caustic soda, which acquired a brown tinge at the common temperature; but when heated, a very deep brown-coloured solution was formed: after repeated digestion with the alkali, I was able to dissolve four hundred grains; the remainder was undecomposed vegetable matter, which was quite insoluble in the alkali I used.

I next added muriatic acid to this alkaline solution, after which the dissolved matter was precipitated of a brown colour, and did not appear to be altered by its combination; for it was still soluble in caustic soda, and ammonia, insoluble in water by boiling, but soluble in spirit of wine. When burnt, a brown-coloured ash is left, which afforded sulphat of lime and oxyd of iron, but in no instance did I find phosphat of iron or phosphat of lime.

PROPERTIES OF THE ACID CONTAINED IN PEAT.

In relating the characters of the aqueous solution, I observed that it tinged litmus paper red.
This

This shows the presence of an acid, which I found to possess the following characters.—

1. It is not crystallizable, but may be obtained by evaporation, in the form of thin crusts.

2. Taste, slightly acid.

3. Forms compounds with lime, barytes and soda, which I have not particularly examined. The compound of lime and this acid is difficultly soluble in water, which distinguishes it on the one hand from the gallic acid, as it forms a very soluble compound with lime; on the other, from the oxalic, which forms an insoluble salt with lime*.

4.

* Lord Dundonald affirms, that peat contains the oxalic and phosphoric acids, which, according to his explanation, are of great use in several of the operations of nature; thus, when lime is added to peat, it is imagined that an oxalat of lime is formed, which, by the addition of sulphuric acid is decomposed, and a gypsum formed, while the oxalic acid enters into new combinations, useful in promoting the growth of plants. We have already shown, however, that this acid is very different from the oxalic; but allowing it to be the same, it is contrary to well known chemical affinity to suppose that the sulphuric acid can decompose the oxalat of lime.— In the experiments I have made, none of the combinations of phosphoric acid appeared.

4. Decomposes the acetite and nitrat of lead.
5. With fulphat of copper, a copious brown-coloured precipitate is formed, having a beautiful green supernatant liquor.
6. With fulphat of iron, it forms a brown precipitate, and a nearly colourless supernatant liquor.
8. Nitrat of copper changes the solution to a beautiful green, without causing any precipitation. In this it also differs from the oxalic acid, which causes a copious precipitation.
9. Muriat, and nitrat of barytes are decomposed by it.
10. With solution of fulphat of indigo, it forms a beautiful green colour; in this it also differs from the oxalic acid, which does not produce any change of colour.

This acid appears to be the same with the fuberique acid, lately discovered by Buillon La Grange, and which he imagines to be a compound of

of carbon, hydrogen and oxygen : Several facts, which I have remarked in a series of experiments concerning the action of the nitrous acid upon charcoal, lead me at present to suppose it to be a compound of carbon and oxygen. On that account I shall now give a short detail of the most interesting phenomena that occurred in these experiments.

I found, by the action of nitrous acid upon charcoal, that a brown, bitter, somewhat deliquescent mass was formed, which was soluble in water, spirit of wine, and alkalies, and emitted a most fragrant aromatic odour, particularly when heated. This matter could be rendered more or less soluble in water, according to the length of time it was exposed to the action of the acid ; but if the acid was strong, and in considerable quantity, a considerable proportion of the charcoal was converted into an acid, which presented the following character of the acid from charcoal :

1. Tinges litmus paper red.
2. Is not crystallizable ; forms only thin transparent crusts by evaporation
3. Forms

3. Forms compounds with barytes, potash, soda, lime and ammonia; and the following is their order of affinity for the acid:—

Barytes,
Potash,
Soda,
Lime,
Ammonia.

4. It decomposes the nitrat and muriat of barytes.

5. When combined with lime, the compound is decomposed by the oxalic acid, which shows a very decided difference between this acid and the oxalic.

6. With solution of sulphat of indigo, it forms a beautiful green colour.

7. With solution of sulphat of zinc, a slight precipitation was produced.

8. With sulphat of iron, sulphat of copper, nitrat

trat of lead, and nitrat of copper, the same appearances were produced as with the acid from peat.

The properties of this acid are similar to that of the suberique ; of course to the acid of peat ; if then we can render it probable, that any one of them is composed of carbon and oxygen, it follows that the others are to be viewed as the same.

Charcoal is now allowed to be the carbonaceous basis, deprived of hydrogen, and when all earthy and saline matters are separated, we have it in the purest state possible, when it is called Carbon*.

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If

* The ingenious Dr Bancroft, in his book upon Dying, conjectures, that charcoal is a vegetable oxyd ; that is, the carbonaceous basis, combined with a small portion of oxygen. The principal objection to the common opinion, is the great indestructibility, and the black colour of charcoal ; for, says he, “ if this did “ not depend on an absorption of oxygen, and did it really exist “ with its black colour, naturally in vegetables, why do not we “ find it remaining entire, after the other parts of vegetables are “ separated or destroyed by fermentation and putrefaction ? and “ why does it dissolve and rot with them undistinguished, and “ contrary to what happens when it exists separately in the form “ of charcoal ; and why, in this form, will it not recombine with “ matter,

If we can then form an acid by the action of nitrous acid upon charcoal or carbon, it is probable that such an acid would contain no hydrogen as a constituent part. We have found, that when the nitrous acid is digested with well burnt charcoal, that a bitter, somewhat deliquescent mass is formed; but, by the decomposition of a greater or less portion of the acid, the bitter matter is rendered more or less soluble; and lastly, we can convert it into the state of an acid. We cannot explain these phenomena, but by supposing that the nitrous

“ matters similar to those separated from it, and enter with them
“ into fermentation, as it surely ought to do if it had acquired no
“ new property, and was only left in a distinct form, and by the
“ simple abstraction of those matters ?”

The question is easily answered; we well know, that vegetable matters, when they undergo the putrefactive process, lose their texture, their constituent parts are separated, and a small portion of carbonaceous substance is left behind; but this is in so minute a state of division, that in length of time, it is carried away in the form of carbonic acid, or carbonated hydrogen, or part is converted into suberique acid. The supposed impossibility of charcoal entering into fermentation is hypothetical. We know, from a fact which has been observed in Germany, that charcoal will undergo all the fermentation it could when in combination with hydrogen; that is, carbonic acid and carbonated hydrogen will be separated by the action of water at the common temperature.

trous acid is decomposed, its oxygen uniting with the carbon, being the cause of the changes which are produced. In the first place, by the addition of a small portion of oxygen, the charcoal is converted into a bitter matter, which is more or less soluble according to the quantity of oxygen which it receives; and if a greater proportion of oxygen is added, the acid is formed. Deyeux, in the 17th volume of *Annales de Chymie*, observes, that the gallic acid being exposed to a gentle heat, a quantity of oxygen was separated, but in no instance could he obtain hydrogen; from this he concludes, that the gallic acid is a combination of carbon and oxygen. This fact renders the explanation which I have now stated greatly more probable, particularly when it is remembered, that the suberique and the gallic acids are very much allied in their chemical properties. It will not then be reasoning too rapidly to conclude, that the suberique, gallic and carbonic acids differ from each other only in the proportion of their constituent parts.

THEORY OF ITS FORMATION.—Many opinions have been proposed with regard to the ori-

gin and formation of peat ; opinions, as is usual on such occasions, very various, and often whimsical. One class of observers have contented themselves by endeavouring to show that it is of vegetable origin, and have only differed as to the probability of wood, or moss alone, or jointly, having formed it ; other observers again, having admitted its vegetable origin, differ only in the explanation of the means which nature uses in the preservation of the vegetable remains. Lastly, it has been conjectured, that it is a *live vegetable, sui generis* ; and an elegant poet having admitted its vegetable origin, has supposed some changes it undergoes by elutriation, &c.

There can be no question of the vegetable origin of this substance : any other opinion is but vain and frivolous : and, it is also inconsistent with fact, to assert, that either wood or moss singly are the only substances that form peat ; for we know that in most cases they both contribute to its formation. In considering the peculiar state of preservation of the vegetable matter in peat, it is very generally believed that fallen wood, when it begins to putrify, produces an extract of the nature of tan, which
preserves

preserves the moss that grows up among the trees, and converts it into peat. This opinion is founded upon the known action of astringent substances in preserving animal nature from decay ; it will therefore be necessary to examine this process, to discover if it will help us to explain the phenomena of peat. It is but lately that we have had any probable explanation of the tanning process ; and we are indebted to an excellent chemist, Seguin, for some interesting experiments and observations upon this subject *. He informs us, that oak bark, &c. contains two substances, the tanning principle, which has a great affinity for gluten, and the gallic acid, which has a powerful attraction for oxygen. When a solution of bark is applied to skins, he supposes that the gallic acid abstracts oxygen from it, by which it is reduced to the state of gluten, which immediately combines with the tanning principle, forming a compound, which is the cause of the indestructibility of leather. We have already shown that peat does not contain the gallic acid ; but allowing that it does, it is impossible to conceive such an action to take place with regard to vegetable matters, particularly

* Journal of the Polytechnic School of France.

ly in peat, which I have found from experiment to contain no tanning principle. It will therefore be necessary to investigate the influence of vegetable acids, &c. upon vegetable matters, before any probable opinion of this kind can be formed.

The singularity of the appearance which peat presents, has led Dr Anderson to conclude, that it is a *live vegetable, sui generis*. This he imagines to be very satisfactorily proved, from the supposed impossibility of decaying vegetables possessing properties similar to peat. He remarks, " That in vegetables, which have once fallen into a state of putrescency, their inflammability decreases in proportion as that putrescency augments; and that their chemical qualities suffer an alteration proportioned to the same circumstance. But by the hypothesis of every person who supposes that sphagnum is the original constituent matter of moss, it is always understood that the foggy peat, by their hypothesis, is the sphagnum still so little decayed, as not yet to have become perfect moss; and that in process of time, it gradually becomes more and more perfect moss, as it gradually becomes more thoroughly putrid, till at last,

“ last, it loses even the appearance of sphagnum,
“ and becomes hard, and perfect peat ; that is to
“ say, in other words, as it becomes more putrid,
“ it becomes more inflammable, which is directly
“ the reverse of the well known progress of na-
“ ture in every other case.” It is upon this and
some similar arguments, that the Doctor rejects
the opinion of moss being a collection of decaying
vegetable matters. But to these we may shortly
answer, that decaying vegetables only lose their
power of burning, with the destruction of their
carbonaceous matter ; but this we know requires
a very long series of years, and when the vegetable
matters are in a moist situation, as is the case with
peat, such a decomposition may be prevented for
hundreds of years.

The last theoretical opinion with regard to peat,
which I shall mention, is contained in a note of
Dr Darwin's beautiful poem, the Botanic Garden.
He there gives us a truly strange account of the
changes which peat moss undergoes by elutriation,
fermentation, and the consequent heat. As this is
little less than a *dream*, it might be passed over ; but
it is detailed in the form of matter of fact, and there-
fore

fore requires to be noticed. He remarks, " That morasses, in great length of time, undergo a variety of changes; first by elutriation, and afterwards by fermentation, and the consequent heat. By water perpetually oozing through them, the most soluble parts are washed away, as the essential salts; these, together with the salts from animal recrements, are carried down the rivers into the sea, where all of them seem to decompose each other, except the marine salt. Hence the ashes of peat contain no alkali; and are not used in the countries where peat is used as the fuel of the lower orders, for the purpose of washing linen. The second thing which is always seen oozing from morasses, is iron in solution, which produces chalybeate springs, from whence depositions of ochre and variety of iron ores. The third elutriation seems to consist of vegetable acid, which, by means unknown, is converted into all the other acids. 1st. Into marine and nitrous acids; 2d. into vitriolic acid, which is found in some morasses so plentifully, as to preserve the bodies of animals from putrefaction, which have been buried in them; and this acid, carried away by rains and dews, and meeting with calcareous earth, produces
gypsum

gypsum or alabaster, with clay it produces alum, and, deprived of its vital air, produces sulphur. 3d. Fluor acid, which being washed away, and meeting with calcareous earth, produces fluor or cubic spar. 4th. The siliceous acid, which seems to have been disseminated in great quantity, either by solution in water, or by solution in air, and appears to have produced the sand in the sea, uniting with calcareous earth previously dissolved in that element, from which have been afterwards formed some of the gritstone rocks, by means of a siliceous or calcareous cement. By its union with calcareous earth in the morass, other strata of siliceous sand have been produced; and by the mixture of this earth with clay and lime arose the beds of marl." After this follow some whimsical notions about the formation of coal, which are connected with some supposed change produced by fermentation and heat. We shall now, in as few words as possible, examine the truth of the supposed change by elutriation, which is all that interests us at present. As to the first position, that the salts are carried to the sea and decompose each other, we have no manner of probability, far less proof. The third stage of elutriation, where

a vegetable acid makes its appearance, should have been confirmed by experiment; its supposed conversion into marine and nitrous acids is perfectly chimerical. The existence of the uncombined sulphuric or vitriolic acid in peat, or in any other matter, is perfectly ideal *: Allowing its presence, what kind of preservation would it induce? it would be that of *decomposition*: for we well know its powerful and speedy action upon all animal and vegetable matters. The existence of the fluor acid in morasses, and the speculations about the filiceous acid, are all conjectures as odd and improbable as could be contrived.

Having now mentioned the principal characters with regard to the formation of peat, and having stated

* "The common vitriolic acid, I believe, has never been found in nature, free from all combination, though it may unite with some bodies beyond the point of saturation. It is true, Mr Baltaffari says, he found some dry concentrated vitriolic acid adhering to selenite, in a grotto in Monte Zaccolina, near Sienna; but this has been fully disproved by the subsequent observations of Mr Murray, in the 7th volume of the Memoirs of Stockholm, and of Mr Dolomieu, in his Notes upon Bergmann de Prod. Volcan. page 88."

KIRWAN'S MINERALOGY. VOL. II. P 2.

stated such objections as occurred to me, I will now endeavour to ascertain, upon chemical principles, the peculiar state of the vegetable matter when in the form of peat. In viewing the various phenomena of decaying vegetables, two distinct stages may be usually observed, the acetous, and putrefactive fermentations. These processes are much modified by circumstances, depending upon the degree of heat, moisture, the presence of air, and the greater or longer continuance of the action of these agents. The putrefactive fermentation is the one which here claims our chief notice, for attention to the appearances it presents will enable us to judge best of the state of the vegetable matter in peat.

In the putrefactive process, if the heat be considerable, the destruction of the vegetable matter is soon accomplished; the whole is dissipated in the form of carbonic acid, carbonated hydrogen, and sometimes ammonia; a small portion of charcoal and ashes being left behind,* a more mode-

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rate

* It is plain, that, in general, wherever carbonic acid and carbonated hydrogen gases are formed, both earthy and saline matters will

rate degree of heat, with moisture, allows the matters to decompose more slowly, and to present the vegetable matter in several other intermediate stages, such as we observe with regard to peat when more or less decomposed. A very great proportion of moisture has a powerful influence in retarding this process; thus the trees which are found at the bottom of mosses, are fresher than those at the top, owing to the bottom containing a greater quantity of water; and the stakes, lately taken out of the Thames, is another remarkable instance of this.

From these circumstances it is plain, that peat is a vegetable substance, which has undergone in part, and is still undergoing the changes which have

will be left behind; for carbon, which enters into the composition of these gases, contains neither earthy nor saline matters. This being admitted, we can account for the presence of saline matters in plants, without any great stretch of hypothesis. It has been lately discovered by Lampadius, Professor of Chemistry at Friburgh, that charcoal decomposes water at the common temperature; and as all soils contain carbonaceous matter, it is plain, that during the formation of these gases by the action of the sun's rays, a quantity of saline matter will be left in the soil for the use of vegetables.

have been just mentioned; and many facts lead me to conclude, that the common peat or quick moss, is the vegetable matter, deprived of a considerable portion of its *hydrogen*. Not only the circumstances attending the situation and appearance of peat, but also other facts render this opinion probable.

1. Sulphuric acid being added slowly to oils, and triturated, they gradually become brown, when the oil is rendered soluble in water and spirit of wine; but if the acid be added in too great quantity, a black insoluble matter is formed.

2. If oleum animale be exposed to the action of oxygenous gas, water is formed, and carbon precipitated.

In this last experiment, we perceive, that the separation of hydrogen causes the precipitation of carbon; in the same way, in the experiment with sulphuric acid and oil, we observe, that in proportion as the hydrogen is dissipated, the carbonaceous basis becomes more or less soluble in water; and when the whole of the hydrogen disappears, a
true

true carbon is left behind. In the same manner; with regard to peat, the woody, or other vegetable matters, are slowly deprived of a portion of their hydrogen, become brown and somewhat soluble in water and spirit of wine. By a further decomposition, more hydrogen is separated, when the vegetable matter becomes insoluble in water, but still soluble in alkali; lastly, nearly the whole of the hydrogen is separated, when a black substance is left, what is called Peat Earth. This last, by long exposure to the air, combines with a portion of oxygen, forming fuberique acid, and appears to be what Lord Dundonald calls Oxygenated Peat.

If this explanation be thought to have probability in its favour, we may explain some other facts in a pretty satisfactory manner. Thus the great Capt. Cook remarks, that the coast of Tierra del Fuego, is covered with peat-moss, and the water which runs from it has a brown turbid appearance. At one time he was obliged to water upon this dreary spot, and could obtain no other water but that from the peat-moss, which made him very suspicious of its qualities, so that at first it was but sparingly used. Having soon got into the warmer regions of the Pacific

Pacific Ocean, he found that this water deposited a small sediment, became pellucid, and was the most wholesome and freest from putrefaction of any he had on board. It is probable that the infusion of peat acted, in this case, in a similar manner with charcoal (from which it differs but little) by abstracting the putrescent matter. Another curious fact is mentioned by Dr. Plott; that intermittent fevers never occur in the neighbourhood of peat-mosses. This appears to be owing either to the slower decomposition of the organized matter in peat-mosses than in fens, by which a smaller portion of noxious gas is formed; or to the absorption of these gases by the peat matter approaching to the state of charcoal. This last explanation is rendered the more probable from a well known fact, that in churchyards, where a great number of dead bodies are buried, no bad smell is to be perceived, evidently owing to the absorption of the noxious gases, by the carbonaceous matter of the soil.

IMPROVEMENT OF MOSS LAND.—The method of improving peat moss, by means of calcareous earth, is certainly one of the most useful discoveries of the present day, and will, no doubt, form

form an important æra in the annals of agriculture. Not long since peat lands were only considered as useful, on account of the fuel which they afforded: the case is now widely altered; the moss grounds are eagerly sought after, and in the west of Scotland, this mode of improvement is carried on with great spirit, and is repaying the judicious manager very amply*. To give a detailed account of the methods which are followed (and that is the only one that can properly be given) would require a volume, and after all, would be little more than a repetition of what is already known. I shall therefore content myself with endeavouring to apply the preceeding experiments, to explain the mode of action of the calcareous earth. We have

* The Highland Society of Scotland, with their accustomed liberality and desire for improvement, have offered a piece of plate of twenty guineas, for the most approved essay, on the following subject. "An account of the best and easiest method, of converting the various kinds of peat or peat moss, into a manure, either by reducing them to ashes, or by making them undergo the putrid fermentation. Also a medal, value five guineas, for the best Essay on the most proper method of cutting peats, so as to prevent the abuse of mosses; and also the particular seasons of the year when the mosses ought to be flooded, to encourage their growth and renewal."

have already observed that peat contains the fub-
rique acid, or one nearly allied to it, which ap-
pears to be formed in greater quantity the longer
the peat is exposed to the action of the air; thus
affisting in retarding the decomposition of the
peat, of course preventing its being useful in ve-
getation. Marle, shells, and limestone, are useful,
in a triple capacity: in the first place, by remov-
ing the acid, the vegetable matter is allowed to de-
compose more rapidly; secondly, the combination
of this acid with the lime, forms a compound,
which may assist in vegetation; and lastly,
this acid having a stronger attraction for lime
than the carbonic, will disengage it in consider-
able quantity, when it will assist vegetation. I
shall conclude, with remarking, that there is a con-
siderable prejudice in favour of quicklime; if the
explanation now given have any plausibility, it is
plain that carbonat will answer as well, if not
better, in the improvement of mofs lands.

A a

KELP.

K E L P.

THIS useful material does not appear to have been known as a manufacture in Britain, until some time after the beginning of the present century ; owing to the backward state of the soap and glass manufactures, which, particularly in Scotland, have not been carried on with spirit above thirty years. It will not then surprise us, when we learn, that its first introduction was about the year 1730 into the island of Uist, by a Highland gentleman, of the name of M'Leod, who brought it from Ireland, where it had been carried on for many years before. The method he followed was, in all probability, a bad one, as he was satisfied by merely reducing the seaweed to ashes; but this was soon given up, and the plan of fusion, which is now followed, was adopted. This manufacture soon found its way into all the other islands,
for

for we find it forming an article of trade in Shetland, soon after its first introduction into the Hebrides. The quantity of kelp, at first made, was trifling; but the great increase and the rapid progress of the manufactures depending on it, soon raised the price and increased the quantity; the following being, as far as I can collect, pretty nearly the average price of kelp from the year 1740, to the present time.

From 1740 to 1760	average price about	L.2 5s. a ton.
1760 to 1770	- -	4 4s. a ton.
1770 to 1780	- -	5 os. a ton.
1780 to 1790	- -	6 os. a ton.

Since the year 1791, its value has greatly increased, and has now risen to a greater height than was ever known before, owing to the war, which has prevented the importation of the usual quantity of barilla, and has thus raised kelp to the enormous price of L.11 0 0 a ton. In Shetland from 250 to 300 tons are made annually, but this quantity bears so small a proportion to the extent of the lands as not to have affected the rent in an equal degree to that of Orkney, where, within these seven years past, small farms about L.40 rent, have risen to L.300 a year.

In Shetland, the cost of manufacturing is from L.2 to L.2 10s. 0 a ton; but, in the west Highlands, the price of labour is greatly lower, being from L.1 to L.1 10s. a ton; from this we may easily perceive the immense profits. The method of manufacturing is sufficiently simple. The different species of fuci, particularly the *vesiculosus* and *ferratus*, are cut from the rocks in the months of May, June, and July, and spread out and dried so as to enable them to burn more easily. In drying the ware they are very cautious to prevent any fermentation from taking place; for it is found, that ware thus changed, does not afford so good a kelp as when well dried. This curious circumstance is well deserving the attention of the chemical philosopher, as a proper investigation may lead to some curious facts with regard to the decomposition of the muriat of soda, and the nature of alkalies. Mr Headric, in a report upon the subject of manures, to the Board of Agriculture, remarks, "That a person versed in chemistry, informed him, that sea plants when bruised and macerated with water in their fresh state, yield no saline ingredient, excepting sea salt or muriat of soda. That when burnt, they yield vegetable

“ vegetable alkali, or potash, but no soda.” Whatever truth be in these experiments, they certainly deserve to be repeated, particularly as they are rendered somewhat probable from an observation made by intelligent soap manufacturers. They remark, that all kelp made from rotted ware, as is frequently the case upon the coast of Norway, *works soft*, that is, in the manner of potash, forming a soap which becomes soft, if exposed, for some time to the air. The ware being sufficiently dried, a pit is dug upon the shore (generally in the sand) seven feet wide, and three or four feet deep, and is lined with stones. A fire is now kindled in the bottom, and the dried fucus is laid upon it by degrees; they keep adding fresh quantities until the pit is nearly filled, when the whole is frequently stirred; towards the evening the whole gets into a semifluid state; it is then allowed to cool and is afterwards taken out of the pit ready for the market. In this method of burning, a considerable portion of sand and earthy fragments, is unavoidably mixed with the fused mass, besides what is added intentionally by the burners to increase its weight, and, as they imagine, its value. This
notion

notion is very false, as kelp of this kind is easily detected by a skilful merchant; who, of course, reduces its price, and a kelp, which, if honestly prepared, might have brought a good price, is now reduced on this account, one third of its value. Another very material cause of the badness of kelp, is the fusion of the alkali with the filiceous matter, forming a compound, said to be of no use in soap making; as, in this way, a considerable portion of alkali is destroyed.

These observations, which must occur to every one, upon a little reflection, engaged the attention of my father some years ago, who endeavoured, by a series of experiments, to ascertain whether it would be of advantage to burn the wrack in furnaces, where it would not be liable to be mixed with filiceous earth, &c. as, in this way, he imagined he would increase the proportion of alkali, with very little additional expence. Accordingly he erected several furnaces upon different plans, in which the ware was burnt, and the kelps afterwards examined; but a recapitulation of these extensive experiments would be inconsistent with the intended

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ed brevity of this publication ; I shall, therefore, only mention what he conceived to be the best form of a furnace. It consists of one fire place, covered with an arch, which communicates with four reverberating cavities, into which the ware is thrown. This fire place, with a small quantity of fuel, produced a kelp of greater strength than any he had examined during his long practice ; and, upon calculation, it was found that the expence of furnaces and fuel was greatly more than repaid by the increased value of the kelp.

The growing of fuci upon shores, is now become an object of some consequence, not only from their value, as affording kelp, but also on account of their great and successful use as a manure. It has, therefore, been recommended to roll stones upon the shores, which, in many places, can be done at small expence, and these in two years, become covered with fuci, in such quantity as to be cut. Calcareous stones are found to answer best, by far. It is also worthy of remark that a greater quantity of ware is to be got at the bottom of a bay, than at its sides, where

where the ware is more exposed to the violent action of the tides and waves.

Merchants, in their examination of kelps, are possessed of a few rules, which they generally follow, in determining their relative value; the chief of these are; taste, smell, colour, compactness, and general appearance. That these will enable us to guess vaguely at their value, cannot be denied, but any thing like certainty is not to be expected. A person, no doubt, who has been in the long habit of using these characters, will, after sad experience, be more expert at this guessing than another. It requires no foresight to perceive, that trusting to external characters, in so heterogeneous a mass as kelp, must often lead the unwary buyer into a disagreeable predicament, in purchasing as good, what upon actual trial he finds of comparatively little value. These remarks are not idle conjectures; nor are they thrown out to show the utility of a chemical acquaintance with the substance; but founded on facts. I have often seen them verified, to the no small detriment of the manufacturer, and have as often regretted that
so

so little attention should be paid to the ascertaining the proportion of alkali, &c.

Mr Kirwan of Dublin, whose active industry is now well known to all Europe, is the first who has engaged seriously in this investigation; and the results of his labours are detailed in the 3d vol. of the Transactions of the Royal Irish Academy.

Having favourable opportunities, through the good services of some of my friends, of procuring kelp from different quarters of Scotland, Ireland and Norway, I ascertained the proportion of pure or carbonated alkali in each of them; in some by the test of sulphat of argill, which is employed by Mr Kirwan; in others by using an acid of known strength, the method recommended by Dr Black.

Table of the Proportion of Alkali contained in different kinds of Barilla and Kelp.

	In the 100lb.
Barilla from Alicant—good	23½lb.
Tenerif—bad	8 lb. 7 oz. 120 gr.
Kelp from Norway—indifferent	2 lb. 11 oz.
Shetland—indifferent	2 lb. 6 oz.
Island of Lewis—indifferent	2 lb. 11 oz.
Ibid—indifferent	2 lb. 6 oz.

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West

OBSERVATIONS ON

West Highlands—much da-		
maged	-	1-3d of lb,
Arran		
Isla—good	-	4 lb.
Mull—good	-	4½ lb.
Morven—good	-	4½ lb.
Island Skye—good		5 lb.
Leith shores		

In judging of the value of kelp, it is not sufficient that we have ascertained the proportion of soda; several other circumstances must be attended to. In the first place, in judging of the value of a cargo, we must carefully examine its general appearance, which comprehends the size of the masses, the greater or less quantity of mixed stony matter, the degree of compactness, the proportion of diffused charcoal, the causticity, its wetness or dryness, &c. We then take pieces as different as possible from each other, and as expressive of the character of the whole as we can, pound them, and take any determinate quantity, as an ounce, and ascertain the proportion of soda, which being done, will afford us as just an idea of its value, as we can obtain from the nature of circumstances. I have here subjoined the character
of

of one species of kelp from Norway, which will give a better idea of external characters, &c. than could be done otherwise.

KELP FROM NORWAY.

This cargo was composed of pieces generally about half a hundred weight, and little mixed with any in a small powdery state; a considerable portion of stony matter was mixed, not in the form of gravel or sand, but in large masses, which were either in the centre of great pieces of kelp, or were themselves only covered with a coating of it.

Texture—Loose; vesiculæ large and numerous, often filled with charcoal; in other specimens, texture more compact, vesiculæ small, less numerous, not containing charcoal.

N.B. The circumstance of the vesiculæ being more or less numerous, or large, and the presence of charcoal, all show whether or not the fuci have been well burnt.

Colour—Dirty blue, or grey, but when more compact, approaching to the green.

Odour—When breathed upon, emits a faint sulphurous odour.

Taste—Pretty caustic, mixed with that of sea salt.

Hardness—Easily scraped with a knife, often yielding to the knife; but with a considerable degree of toughness.

Dryness—Was so dry as to have efflorescent crystals upon its surface.

Proportion of Alkali—100 lb. contained 2 lb. 6 oz. of soda.

C O A L

C O A L.

AS notwithstanding many unfavourable symptoms, it is not improbable that coal may yet be found in Arran; and as the low east part of the Mainland of Shetland does not present any very unfavourable appearances; on these accounts, I will now mention, in as few words as possible, the symptoms and methods of detecting the presence of such strata or veins.*

1. Coal is never found in primitive mountains.
2. Although sandstone abounds in any country,
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* The existence of coal veins is now well proved; and from what we know, it appears, that when coal is found in such situations, it is but in small quantity. At Castle Leod, in the Highlands, there are interesting appearances of this kind, and I believe also in the island of Mull.

we are not to expect coal, particularly in the red-sandstone districts. This observation is only applicable to Scotland, according to Dr Walker.

3. If the sandstone be of a white colour, and have interposed black bituminous or carbonaceous matters, this may be reckoned a good symptom, as this species is only to be found in the coal countries.

4. If bituminous shale, schiefer thon, and limestone make their appearance, it is a further proof of the vicinity of coal.

5. We should examine the nature of the springs, whether their direction be in that of the strata, and particularly whether they contain small fragments of coal. This symptom is often of considerable importance.

6. Having observed such strata as render the presence of coal probable, we must next endeavour to discover its actual existence. To do this, we must examine the beds and banks of rivulets; if small pieces of coal are detected, we are pretty certain

certain of the existence of coal higher up. We should also examine the soil, as it is thrown up by moles, or the plough; if small angular pieces of coal appear, it may make us suspect its presence. This mark, however, is not to be depended upon, unless we be certain, that no coaly matter has been accidentally mixed in manuring the ground, or in burning limestone. Ditches are also to be examined; for in forming these, we often cut through the thin covering of gravel and sand, which conceals the crop from our view. We often observe here and there small pieces of coal immersed in the argillaceous breccia, which is observed in coal countries; but a good deal of caution is necessary in drawing conclusions from this appearance, when we recollect that this breccia is formed of the debris of all the mountains in an extensive district. We often observe a sooty-like matter spread upon levels, or on the declivity of hills; this is generally formed by the decomposition of coal, and is reckoned a very good symptom of its vicinity.

Having, from some of the preceding circumstances, determined the probable existence of
coal

coal, in a certain district, we must now endeavour to discover the crop, or outburst of the strata. This is a matter of much difficulty, and requires particular attention to the disposition of the fragments of coal, &c. If they be found upon the banks or bed of a rivulet, we must search higher up, to discover the crop of the stratum; if the appearances of footy matter, &c. present themselves, it is very necessary to remark, whether they lie upon a declivity, or a plain; as inattention to these circumstances has often been the cause of great disappointment and expence to the coal miner, in overshooting the stratum, that is, in cutting beyond its real situation. Upon a declivity, we know, that the decomposing and loose matter of a crop, will naturally spread downwards, in proportion to the greater or less elevation of the pente. On this account, wherever appearances of coal occur upon a declivity, we must always trace the debris upwards, when we will find it increase in depth, towards the crop, and the coal is less and less decomposed, as we approach nearer to it. On the other hand, where the footy matter occurs upon a plain, we invariably find it thicker, and
far

far less spread, than upon a declivity; and what is of consequence, it spreads often in a direction contrary to the rise of the strata. This shows us the necessity of a knowledge of the elevation and the direction of the strata; for without this, we cannot search with so much certainty, for the real position of the coal.

8. Having now discovered the direction in which we are to work for the detection of the stratum, we either dig forward towards its dip, or follow the fragments of coal, by a trench, until we have the stratum fairly under our eye. Having discovered the stratum, we can now judge of its thickness, and value. The first is determined by digging through the rock until we find the pavement. Its value is ascertained from the following circumstances.

1st. Its general appearance, whether it be more or less mixed with stony matter, or if there be laminæ, of bituminous shale, or sandstone, dividing it into stratulæ, or if it contains much pyrites, or sulphur of iron.

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2dly, To these may be added the most certain tests, that of chemical analysis, in which we are certain of the proportion of carbon, bitumen and ashes*.

Mr Kirwan, in the second vol. of his Mineralogy, has given us an excellent plan for ascertaining the proportions of carbon, bitumen, and ashes in coal, and has added an interesting table of the composition of several different species.

* Sometimes the coal, near the roof, burns well, but often it is useless, and it is imagined by miners, that the deeper the coal, the better.

I N I S.

